ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME

A THESIS SUBMITTED TO

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT (PUNJAB)

IN THE PARTIAL FULFILLMENT

FOR THE AWARD OF DEGREE OF

DOCTOR OF MEDICINE

IN

Obstetrics & Gynaecology

MAY 2023

Submitted By

DR. RASHIM ANEJA

DEPARTMENT OF OBSTETRICS & GYNAECOLOGY
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA, PUNJAB

DECLARATION BY THE CANDIDATE

I hereby declare that the thesis entitled **"ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME**" submitted towards partial fulfillment of the requirements for the award of **MD in Obstetrics & Gynaecology** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Suman Puri**, Professor & Head(Unit II), Department of Obstetrics & Gynaecology, **Dr. Kamini Gupta**, Professor, Department of Radio-diagnosis and **Dr. Pooja Tandon**, Associate Professor Department of Obstetrics & Gynaecology No part of this thesis has formed the basis for the award of any degree previously.

_____

Dr. Rashim Aneja
Department of Obstetrics & Gynaecology,
Dayanand Medical College & Hospital,
Ludhiana, Punjab

Date:

Place:

CERTIFICATE OF SUPERVISORS

This is to certify that the work incorporated in this thesis entitled "**ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME"** has been carried out by **Dr. Rashim Aneja** under our direct supervision. The data incorporated in this thesis is original and genuine and has been carried out by the candidate herself.

Signature of Supervisor

Dr. Suman Puri
Professor & Head (Unit II)
Department of Obstetrics
& Gynaecology
DMC&H, Ludhiana

Signature of Co-Supervisor

Dr. Kamini Gupta
Professor
Department of Radio-Diagnosis
DMC&H, Ludhiana

Dr. Pooja Tandon
Assoc. Professor
Department of Obstetrics
& Gynaecology
DMC&H, Ludhiana

Date:

ENDORSEMENT BY THE HEAD OF THE INSTITUTE

This is to certify that the thesis entitled “ROLE OF COLOR DOPPLER FLOWMETRY IN **ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME "** is a bonafide research work done by **Dr. Rashim Aneja** under the supervision of **Dr. Suman Puri**, Professor and Head (Unit II), Department of Obstetrics & Gynaecology, **Dr. Kamini Gupta**, Professor, Department of Radio-diagnosis and **Dr. Pooja Tandon**, Assoc. Professor, Department of Obstetrics & Gynaecology in this institution.

Principal

Dr. Sandeep Puri
Principal
DMC&H, Ludhiana

Date:

COPYRIGHT

Declaration by the Candidate

I hereby declare that the Baba Farid University of Heath Sciences, Faridkot, shall have the rights to preserve & use this thesis in print or electronic format for academic/study purpose by the research scholar/students.

Signature

DR. RASHIM ANEJA
Department of Obstetrics & Gynaecology,
Dayanand Medical College & Hospital,
Ludhiana, Punjab

Date:

© Baba Farid University of Health Sciences, Faridkot

ACKNOWLEDGEMENT

The thesis presented in the following pages is a culmination of the support of my professors, and the multiple opportunities presented by my college to refine my work of research.

To start with, I am grateful to the Almighty for bestowing me with the strength and the opportunity to present my research as a thesis.

I would like to extend my sincere gratitude to my esteemed supervisor and professor **Dr. Suman Puri**, for being so supportive throughout, right from the process of narrowing the research topic, to assisting me through the periods of troughs and highs. Her rich expertise in the subjects, years of experience and forward thinking attitude have been a constant blessing. I wish to convey my heartiest thanks to **Dr. Ashima Taneja** for being the most helpful support and due to her able mature guidance and ever willing help, made assigned task simpler and being constant source of strength.

My sincere regards to **Dr.Pooja Tandon**, for motivating and pushing me in academics to do the best for being a great example and being an inspiration due to her equanimity and support throughout the course and my thesis work.

I would like to thank **Dr.Sunil Juneja** , **Dr. Shweta Gupta** and Dr. Kanupriya Jain for their constant encouragement and motivation.

My heartiest thanks to **Dr. Kamini Gupta** without her constant efforts and inputs this could not have been possible.

I wish to thank all my seniors who have been constantly motivating, inspiring, sending heartiest wishes and praying for my prosperity always-

Dr. Pawneet, **Dr. Reetika**, **Dr. Gagan**, **Dr. Manpreet** ,**Dr. Divya** , **Dr. Sukriti** , **Dr.Gaurav,Dr.Riddhima.**

Special mention goes to my juniors **Dr. Janvi**, **Dr. Baljinder**, **Dr. Romi**, with whom working was a pleasure.

I can never forget the timely reminders and wishful messages of Renu ji,who has supported us all immensely throughout this journey.

Words shall be woefully inadequate to express for unfailing attention, love and care by my family –My Mother **Mrs. Janak Aneja** , My Father **Mr. Vijay Aneja,** Sister **Ms. Garima Aneja**, who have made me whatever I am today. I

would like to thank my colleagues Dr.Aman,Dr.Mehak,Dr.Heena and Dr.Kaveri for constant support and motivation throughout.

I would like to extend my sincere gratitude to **Mr. Naveen Bhatia**, Research and development center, for all his patience and guidance from the very beginning. I would like to thank **Mrs. Namita Bansal** and **Mrs. Niharika** for the immense help.

I wish to extend warm regards to the staff and patients for their cooperation. At last, I would like to thank all those who helped me to accomplish this task.

Dr.Rashim Aneja

LIST OF ABBREVIATIONS

FGR	Fetal Growth Restriction
SGA	Small For Gestational Age
LBW	Low Birth Weight
UNICEF	United Nation Children's Fund
RDS	Respiratory Distress Syndrome
BPP	Biophysical Profile
NST	Non Stress Test
CPR	Cerebroplacental Ratio
MCA	Middle Cerebral Artery
S/D	Systolic/Diastolic Ratio
PI	Pulsatility Index
RI	Resistive Index
PORTO	Prospective Observational Trial To Optimize Health In Intrauterine Growth Restriction
PNMR	Perinatal Mortality Rate
AEDV	Absent End Diastolic Velocity
REDV	Reversed End Diastolic Velocity
TRUFFLE	The Trial Of Randomized Umbilical And Fetal Flow In Europe
AC	Abdominal Circumference
EFW	Estimated Fetal Weight
SFH	Symphysio Fundal Height
NICU	Neonatal Intensive Care Unit
Ut-A	Uterine Artery

UA	Umbilical Artery
AEDF	Absent End Diastolic Flow
REDF	Reversed End Diastolic Flow
GP	Group
Kg	Kilogram
APGAR Score	Appearance, Pulse, Grimace, Activity, Respiration Score
Min	Minute
NEC	Necrotising Enterocolitis
POG	Period Of Gestation
HTN	Hypertension
SUA	Single Umbilical Artery
SLE	Systemic Lupus Erythematosus
CMV	Cytomegalovirus
DM	Diabetes Mellitus
AGA	Appropriate For Gestational Age
GA	Gestational Age
IUFD	Intrauterine Fetal Demise
FEDF	Forward End Diastolic Flow
LI	Labor Induction
CS	Cesarean section
DEL	Delivered

ABSTRACT

Introduction: FGR is failure to achieve a specific growth potential which is associated with an increased risk of perinatal mortality and morbidity. The average incidence of FGR is about 8%. FGR is defined as estimated fetal weight <10thpercentile for gestational age. Early detection and timely intervention in FGR babies can help in significantly improving perinatal outcome.

Aim of Study: To evaluate role of Doppler flow parameters in prediction and management of fetal growth restriction in antenatal patients and its correlation with perinatal outcome.

Materials & Methods:A prospective study will be conducted on 100 pregnant women >26 weeks gestation attending antenatal clinic or admitted in department of obstetrics and gynaecology, DMC&H, Ludhiana which is a tertiary care hospital. These patients would be subjected to USG-FWB and Doppler at 26-28 weeks, 28-32 weeks and 32-36 weeks gestation for assessment of fetal well- being and diagnosis of FGR. These neonates will be followed upto 30 days after delivery and various parameters indicating fetal outcome will be recorded. The data would be statistically analyzed.

Results: Proportion of FGR babies in our study came out to be 52%. Uterine artery PI was abnormal in 27(77.1%) babies with birth weight $<10^{th}$ centile for gestational age with a p-value of 0.032 which is statistically significant.UA-S/D ratio was statistically significant in patients with abnormal UA-S/D ratio and babies born with birth weight$<10^{th}$ centile for gestational age with a p-value of 0.001.Majority of MCA-PI was abnormal i.e. $<5^{th}$ centile in patients who presented at 32-36 weeks. AEDF and REDF were associated with extremely high rates of perinatal morbidity and mortality.

Conclusion: For prediction of FGR, ultrasound parameters are more accurate and reliable compared to clinical parameters. Serial ultrasound Doppler evaluation helps to detect FGR early, optimize timing of delivery and improve perinatal outcome.

TABLE OF CONTENTS

S. NO.	TOPIC	PAGES
I	INTRODUCTION	1-3
II	AIMS AND OBJECTIVES	4
III	REVIEW OF LITERATURE	5-16
IV	MATERIALS AND METHODS	17-19
V	OBSERVATIONS AND RESULTS	20-86
VI	DISCUSSION	87-99
VII	SUMMARY AND CONCLUSIONS	100-102
VIII	BIBLIOGRAPHY	103-118

APPENDICES – I

- PROFORMA

  MASTER CHART

APPENDICES – II

- APPROVAL LETTER OF THESIS PLAN
- THESIS PLAN

LIST OF TABLES

Table No.	Title	Page No.
1.	Distribution of patients according to age group	20
2.	Distribution of women according to parity	22
3.	Distribution of women according to occupation	23
4.	Distribution of women according to residential address	24
5.	Distribution of women according to education	25
6.	Distribution according to symphysio-fundal height	26
7.	Distribution according to abdominal circumference	27
8.	Distribution according to ut-a pi at 26-28 weeks	28
9.	Distribution of patients according to Umbilical Artery Pulsatility Index (UA-PI)	29
10.	Distribution of patients according to S/D ratio at 26-28 weeks	30
11.	Distribution of patients according to middle cerebral artery PI at 26-28 weeks	31
12.	Distribution of patients according to uterine artery PI at 28-32 weeks	32
13.	Distribution of patients according to umbilical artery	33
14.	Distribution of patients according to umbilical artery S/D ratio at 28-32 weeks	34
15.	Distribution of patients according to MCA-PI at 28-32 weeks	35
16.	Distribution of patients according to uterine artery PI at 32-36 weeks	36
17.	Distribution of patients according to umbilical artery PI at 32-36 weeks	37
18.	Distribution of patients according to umbilical artery S/D at 32-36 weeks	38
19.	Distribution of patients according to MCA-PI at 32-36 weeks	39

20.	Distribution of women according to the period of gestation at the time of delivery (weeks)	40
21.	Distribution of patients according to the mode of delivery	41
22.	Distribution of women under study according to the baby weight (kg)	42
23.	Distribution of babies according to the Apgar score at 1 min and 5 min of birth	43
24.	Distribution of patients according to NICU admission	45
25.	Distribution of babies according to Maturity	46
26.	Distribution of babies according to indication of NICU admission (n=58)	47
27.	Distribution of babies according to Neonatal Outcome	48
28.	Distribution of babies according to adverse perinatal outcome	49
29.	Age wise distribution between patients with normal and abnormal doppler	51
30.	Comparison of women according to parity between patients having normal and abnormal doppler	54
31.	Distribution of women under study according to occupation	56
32.	Distribution according to education	58
33.	Comparison of women according to symphysio fundal height at 26-28 weeks	61
34.	Comparison of women according to symphysio fundal height at 28-32 weeks	62
35	Comparison of women accoding to symphysio fundal height at 32-36 weeks	63
36.	Distribution according to pregnancy complications	64
37.	Distribution according to mode of delivery	67
38.	Distribution according to nicu admissions	69

39.	Distribution according to birth weight	71
40.	Comparison according to ut-a pi,ua-s/d,mca-pi and birth weight	73
41.	Comparison between birth weight and ultrasound doppler	76
42.	Comparison according to birth weight, ultrasound doppler and admission to nicu	77
43.	Comparison according to birth weight, ultrasound doppler and indication of admission to nicu	79
44.	Comparison according to birth weight, ultrasound doppler and perinatal complications	81
45.	Comparison according to birth weight, ultrasound doppler and neonatal deaths	83
46.	Distribution according to cerebroplacental ratio in aga and sga babies.	85
47.	Barcelona Stage Based Classification and Management of FGR.	99

LIST OF FIGURES

Figure No.	Title	Page No.
1.	Transvaginal ultrasound showing the uterine artery doppler	11
2.	Normal umbilical artery assessment	13
3.	Absent diastolic flow in umbilical artery in fgr	14
4.	Reversal diastolic flow in umbilical artery in fgr	15
5.	Distribution of patients according to age group	21
6.	Distribution of women according to parity	22
7.	Distribution of women according to occupation	23
8.	Distribution of women according to residential address	24
9.	Distribution of women according to education	25
10.	Distribution according to symphysio-fundal height	26
11.	Distribution according to abdominal circumference	27
12.	Distribution according to ut-a pi at 26-28 weeks	28
13.	Distribution of patients according to umbilical artery pulsatility index (ua-pi)	29
14.	Distribution of patients according to s/d ratio at 26-28 weeks	30
15.	Distribution of patients according to middle cerebral artery pi at 26-28 weeks	31
16.	Distribution of patients according to uterine artery pi at 28-32 weeks	32
17.	Distribution of patients according to umbilical artery pi at 28-32 weeks	33
18.	Distribution of patients according to umbilical artery s/d ratio at 28-32 weeks	34
19.	Distribution of patients according to mca-pi at 28-32 weeks	35

20.	Distribution of patients according to uterine artery pi at 32-36 weeks	36
21.	Distribution of patients according to umbilical artery pi at 32-36 weeks	37
22.	Distribution of patients according to umbilical artery s/d at 32-36 weeks	38
23.	Distribution of patients according to mca-pi at 32-36 weeks	39
24.	Distribution of women according to the period of gestation at the time of delivery (weeks)	40
25.	Distribution of patients according to the mode of delivery	41
26.	Distribution of women under study according to the baby weight (kg)	42
27.	Distribution of babies according to the apgar score at 1 min and 5 min of birth	44
28.	Distribution of patients according to nicu admission	45
29.	Distribution of babies according to maturity	46
30.	Distribution of babies according to indication of nicu admission (n=58)	47
31.	Distribution of babies according to neonatal outcome	48
32.	Distribution of babies according to adverse perinatal outcome	50
33.	Age wise distribution between patients with normal and abnormal doppler	53
34.	Comparison of women according to parity between patients having normal and abnormal doppler	55
35.	Distribution of women under study according to occupation	57
36.	Distribution according to education	60
37.	Comparison of women according to symphysio fundal height at 26-28 weeks	61
38.	Comparison of women according to symphysio fundal height at 28-32 weeks	62

39.	Comparison of women accoding to symphysio fundal height at 32-36 weeks	63
40.	Distribution according to pregnancy complications	66
41.	Distribution according to mode of delivery	68
42.	Distribution according to nicu admissions	70
43.	Distribution according to birth weight	72
44.	Comparison according to ut-a pi,ua-s/d,mca-pi and birth weight	75
45.	Comparison between birth weight and ultrasound doppler	76
46.	Comparison according to birth weight, ultrasound doppler and admission to nicu	78
47.	Comparison according to birth weight, ultrasound doppler and indication of admission to nicu	80
48	Comparison according to birth weight, ultrasound doppler and perinatal complications	82
49	Comparison according to birth weight, ultrasound doppler and neonatal deaths.	84

INTRODUCTION

Newborns weighing <10th percentile for their gestational age are known as small for gestational age (SGA) babies [1].

Fetal growth restriction (FGR) refers to a fetus that has failed to achieve its genetically determined growth potential due to associated with maternal, placental and/or fetal conditions [2].Low birth weight (LBW) is defined as birth weight less than 2500g and should not be confused with FGR / SGA, as this definition is based on irrespective of gestational age, sex, race, and clinical features [3].

Incidence of FGR is relatively lower in developed countries i.e 4-8 percent as compared to that in developing countries where incidence is 6-30 percent [4]. Average incidence of FGR is 8 percent in general population [4]. FGR has a strong association with poor pregnancy outcome.

In India, according to recent UNICEF surveys, the incidence of FGR is 25-30 percent [5].

The prevalence of low birth weight baby (LBW) is 33 percent [4]. More than 50 percent of stillbirth baby are associated with FGR and nearly 10 percent of perinatal mortality is a consequence of undetected FGR [4].

There is a diagnostic challenge to distinguish SGA from FGR. SGA pregnancies have a good prognosis as compared to FGR pregnancies [6]. 50-70% of the Small-for-Gestation Age (SGA) fetuses are constitutionally small but healthy [7]. Approximately 10-15% of SGA fetuses are classified as ‘true’ FGR cases, and about 5-10% are associated with chromosomal/structural anomalies and chronic intrauterine infections [8]. Such FGR babies end up with low birth weight.

Many neonatal complications are associated with FGR amongst which most common is Respiratory Distress Syndrome (RDS) which can be mild, moderate or severe. Other neonatal complications include polycythemia,

hypoglycemia, intraventricular hemorrhage, still birth and neurodevelopmental impairment. Currently fewer interventions exist to prevent FGR, but the surveillance of growth-restricted fetuses makes it possible to plan a timely delivery in order to avoid severe fetal compromise or death [9,10]. FGR has a strong association with poor pregnancy outcome.

Growth restricted fetuses have not reached their genetic growth potential either due to a pathological cause or an event in utero which causes placental dysfunction. Placenta is the only nutritional support available to fetus. Maintenance of good utero-placental circulation is essential to continue a normal pregnancy. As the pregnancy advances, there are a number of changes that occur in maternal, placental and fetal vasculature. Abnormal vascular resistance patterns develop if there is an inability to adapt to these changes leading to compromise of fetal well-being and ultimately FGR. During FGR, the ability of placenta to provide adequate nutrition to the fetus is restricted, thus resulting in developmental problems and poor perinatal outcome.

Pregnancies which are associated with certain specific risk factors have a higher likelihood of complicating into FGR. Majority of such patients present for first time for antenatal examination in their third trimester.

FGR is mainly due to increase in resistance within the placental circulation leading decrease in velocity in feeding arteries resulting in slowing of diastolic relative to systolic flow. Hence leading to elevation of a number of Doppler indices including systolic/diastolic ration, pulsatility index and resistive index.

Screening for FGR is thus a central component of prenatal care. Early diagnosis of FGR can be done by a combination of medical and obstetric history, clinical examination and ultrasound fetal wellbeing and Doppler. Ultrasound is frequently utilized in antenatal period to assess fetal size

through serial biometric measurement. Further evaluation of FGR includes the bio physical profile (BPP) and the non-stress test (NST). Unfortunately, neither of these tests is particularly sensitive for predicting poor outcome in FGR pregnancies. Uterine artery Doppler, Umbilical artery Doppler, middle cerebral artery Doppler, cerebroplacentalratio (CPR), Ductusvenosus Doppler are nowadays used for FGR evaluation, prognostication and management of such pregnancies. Earlier invasive methods such as amniocentesis and fetal blood sampling had to be performed repeatedly for evaluation and prognostication of FGR babies which was cumbersome. This non-invasive method has made assessment of pregnancies with FGR simpler compared to invasive methods.

Uterine artery doppler provides knowledge of maternal circulation, whereas the umbilical and middle cerebral arteries provide us with information regarding fetal circulation.

There is limited sensitivity and specificity of uterine artery Doppler to predict adverse outcome in FGR fetuses which have been diagnosed during third trimester [11]. Umbilical artery Doppler assessment is useful in surveillance and obstetrical management of early onset FGR. MCA Doppler is an important tool in deciding the timing of delivery especially when the umbilical artery Doppler is normal.

SGA fetuses often exhibit normal antenatal fetal Doppler [12].

At present there is no effective treatment to reverse the course of FGR except delivering the growth restricted fetus. Accurate surveillance, antenatal management and timing of delivery can help in improving neonatal outcomes.

AIMS AND OBJECTIVES

- To evaluate role of Doppler flow parameters in prediction and management of fetal growth restriction in antenatal patients.

- To correlate Doppler flow parameters with perinatal outcome.

REVIEW OF LITERATURE

The use of ultrasound Doppler to investigate the pattern of waveforms in the umbilical artery during pregnancy has been first reported in 1977 from Dublin[13]. The waveforms were derived from the changes in the frequency of the Doppler signal, which targeted the circulating fetal blood within umbilical artery. Over the last 25 years, Doppler velocimetry has become a routine part of fetal surveillance for the diagnosis of FGR pregnancies, their antenatal management and timing of delivery to improve fetal and neonatal outcomes. Circulatory adaptation of the fetus in the presence of uteroplacental insufficiency in FGR leads to perfusion of blood preferentially to vital organs such as brain, heart [14], adrenal glands [15], and spleen [16,17]. Ultrasound Doppler surveillance is based on this relationship between circulatory changes and the fetal condition [18].

FGR is mainly caused due to an increase in resistance within the placental circulation which leads to a decrease in velocity in feeding arteries especially during diastole compared to systole [19]. A Disproportionate slowing of diastolic flow relative to systolic flow leads to an elevation of a number of Doppler indices, which includes the systolic/diastolic ratio and pulsatility index [20].

Uterine artery Doppler, umbilical artery Doppler and middle cerebral artery Doppler are commonly used nowadays for FGR evaluation.

Umbilical artery Doppler is now being extensively used in prediction of fetal growth restriction and their perinatal outcomes [21]. Uterine artery Doppler, although has limited sensitivity and specificity in predicting adverse outcomes in FGR fetuses which have been diagnosed during third trimester, gives information about maternal circulation [22], whereas umbilical and middle cerebral arteries provide information about the fetal circulation. Absent or reversed end diastolic flow in umbilical artery is usually associated with an increased risk of perinatal mortality. Fetal MCA

Doppler is a good predictor of fetal hypoxemia as suggested by an increase in diastolic blood velocity which presents as a sign of fetal brain sparing [23].

A fetus with severe growth restriction first demonstrates changes in the umbilical artery as reduced end – diastolic flow followed by an increase in end- diastolic flow in middle cerebral artery (MCA). This is followed by changes in venous circulation i.e. ductus venosus suggested by decrease in forward flow during atrial systole.

Fetal growth restriction is associated with an increased risk of intrauterine fetal death, neonatal morbidity and mortality [24]. Antenatal detection and surveillance along with optimizing timing of delivery are important to improve pregnancy outcomes.

Pregnancies which are associated with specific risk factors have a higher likelihood of complicating into FGR. Many such patients usually present in their third trimester for first time for their antenatal examination. Such patients need a highly sensitive and specific diagnostic test which can be applied non-invasively on a large scale. In the era of real time ultrasound, antenatal diagnosis of fetal growth restriction has become very easy, thus minimizing future catastrophe.

Due to FGR the total neonatal deaths in low- and middle-income countries due to FGR are 21.9% [25]. Current antenatal detection rates of FGR are reported to be between 25 to 36% [26]. The risk of stillbirth in pregnancies in whom FGR has been identified prenatally is 1% (9.7/1,000 births). There is 8 told increased risk of stillbirth in pregnancies which have an unrecognized FGR when compared to pregnancies without FGR (19.8 versus 2.4/1000 births) [27].

In the PORTO multicenter cohort study (2014), the perinatal mortality rate (PNMR) in FGR cases which were identified prenatally was 5.4/1,000 which compared favorably to the overall national rate of 4.1/1,000 births,

which can be attributed to increased ultrasound doppler surveillance and planning a timely delivery [28].

FGR can be broadly classified on the basis of gestational age when they are diagnosed i.e. early onset FGR (<32 weeks) and late onset FGR (≥ 32 weeks). The rationale under-lying this classification is based on differences in severity, natural history, Doppler findings, association with hypertensive complications, placental findings, and management [29-31].

Early onset FGR constitutes nearly 20-30 percent of all FGR pregnancies, is more severe, easier to detect and more likely has an abnormal umbilical artery Doppler as compared to late onset FGR which has a strong association with gestational hypertension and/or pre-eclampsia in nearly 70 percent cases [32].

Late onset FGR constitutes approximately 70-80 percent of FGR cases, is mild, shows a weak association with hypertension (10 percent) and is usually associated with a normal umbilical artery Doppler [33].

Pathophysiology

In FGR, there is a compromise in the supply of nutrients which reach the fetus to which the fetus responds by reducing its overall size but preserves certain functions like brain growth, lung maturation, and increasing red blood cell production [34]. In up to 60 percent cases, cause of placental insufficiency is unknown, where there is an absence in the remodeling of uterine spiral arteries which results in restricted uteroplacental perfusion [35].There is preferential redistribution of blood flow to vital organs like brain, myocardium and adrenal glands compared to other organs including GI system and skin which are deprived of sufficient blood flow. This redistribution occurs as a result of hypoxia which is reflected as changes in uterine, umbilical and middle cerebral artery flow [36]. There is a

decrease in total body fat and minerals in infants with severe FGR, which gives the fetus a wasted appearance [37].

FGR occurs as a result of maternal, placental and/or fetal factors that interfere with the normal mechanisms that regulate fetal growth [38, 39].

Common etiologies of fetal growth restriction are [40]:

1) Maternal (preplacental) factors
- Hypoxemia (chronic lung disease, high altitude)
- Anemia
- Smoking, substance abuse (cocaine, methamphetamines)
- Malabsorption
- Environmental toxins like air pollution, heavy metals (lead, mercury)

2) Placental factors
- Maternal vascular malperfusion pathology (infarction, fibrin deposition, chronic abruption)
- Fetal vascular malperfusion pathology
- Placental inflammation (e.g. villitis of unknown etiology)

3) Umbilical cord (postplacental) factors
- Increased coiling and cord length
- True knot
- Single umbilical artery
- Marginal or velamentous cord insertion

4) Fetal disorders
- Genetic disorders (chromosomal, microdeletions/duplications, single site mutations, epigenetic disorders)
- Structural anomalies (e.g. congenital heart disease, gastroschisis)

- Congenital infections (cytomegalovirus, toxoplasmosis, herpes, rubella, syphilis)
- Teratogen exposure (drugs, toxins)

5) Race and Ethnicity

It has been widely recognized that parental characteristics and ethnicity have a primary influence in determining the “normal” fetal growth and neonatal birth weight [41].

6) Fetal Gender

In 1996 Marsál et al, found that fetal gender influences intrauterine growth rate and consequently birth weight of fetus [42]. Male infants have higher birth weight than females at the same gestational age, and at term this difference is approximately 100 gram. De Jong et al in1998 found that the gender difference in fetal growth becomes apparent in the third trimester of gestation, and recent studies have shown that it is partly mediated by an increase in growth of the male fetus in the last two gestational weeks [43].

Risks associated with fetal growth restriction

The most catastrophic risk associated with fetal growth restriction is stillbirth [44] with an established relationship between birth weight and risk of stillbirth with risk more in preterm compared with term babies [45].

FGR is a very important cause of iatrogenic preterm birth [46] and is considered as an independent risk factor for spontaneous preterm birth [47] with early and timely delivery considered as the mainstay and the only strategy for preventing stillbirths in cases of severe FGR [48].

Other complications include pre-eclampsia and abruption placentae [49].

Further FGR babies have a higher risk of neurodevelopment impairment [50] and non- communicable diseases as compared to fetuses with normal growth [51].

Early prediction of FGR

It is important to identify women who are at high risk of FGR and who may benefit from preventive strategies and close monitoring during pregnancy.

It is critically important to differentiate between fetuses that are SGA and are constitutionally small and healthy compared to those who are growth restricted due to FGR.

Antenatal ultrasound Doppler assessment is an integral part in the diagnosis, management and timely delivery of FGR babies.

Any abnormal doppler findings present in uterine, umbilical and middle cerebral vessels is highly suggestive of ongoing placental dysfunction and a need for intervention.

There may be normal umbilical artery doppler findings in early stages of FGR but this does not rule out early placental dysfunction and hence serial monitoring has to be done in all cases of suspected FGR[52].

Uterine artery doppler abnormality should kept in consideration more in cases where suspicion of primary placental FGR is present.

Uterine artery doppler

Uterine artery Doppler velocimetry helps in assessment of maternal component of placental blood flow and is a marker of remodeling of spiral arteries by the trophoblastic cells.

In a normal pregnancy, remodeling of spiral artery results in a low resistance flow in the vessel and is indicated by presence of high velocity and continuous forward flow in diastole [53].

This mechanism helps in optimal delivery of oxygen and nutrients to the fetus. Early onset FGR is characterized by failure of trophoblastic invasion of spiral arteries resulting in a reduced uteroplacental perfusion [53].

Abnormal uterine artery doppler is defined as a PI which is greater than 95th percentile for that gestational age or the presence of a diastolic notch and is associated with many adverse perinatal outcomes like pre-eclampsia, FGR and perinatal morbidity and mortality[54,55-61].

However, uterine artery Doppler has a limited diagnostic and clinical utility in predicting FGR, SGA and perinatal mortality [62-63].

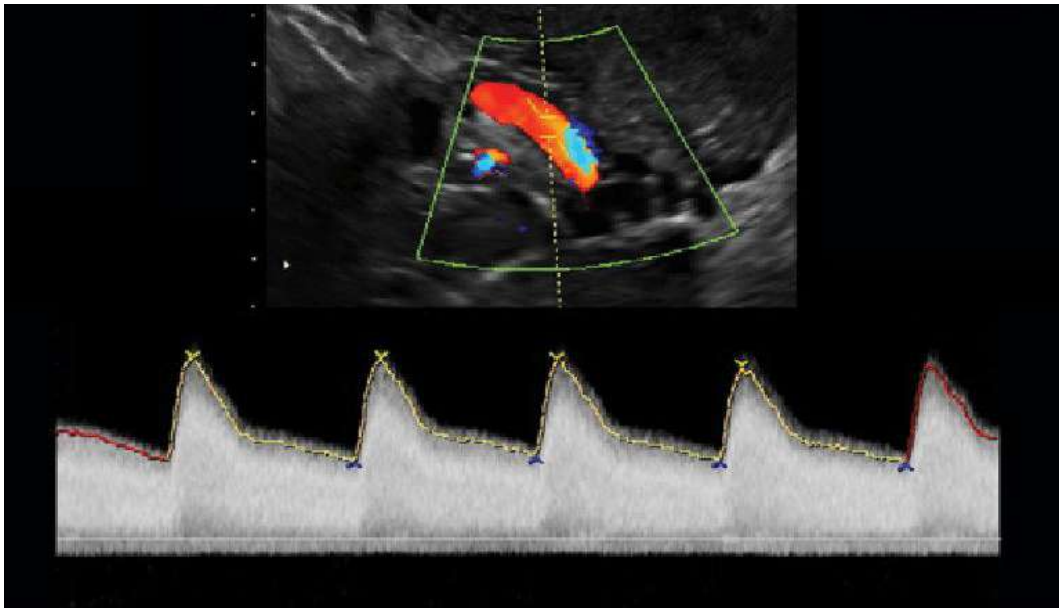


Figure 1. **Transvaginal ultrasound showing the uterine artery Doppler [64] .**

Reference range for uterine artery PI [65]

UTERINE ARTERY PI	5^{th} centile	95^{th} centile
26-28 weeks	0.82	1.32
28-32 weeks	0.74	1.08
28-32 weeks	0.67	1.20

Umbilical artery doppler

Umbilical artery doppler assesses the blood flow in the fetal component of placental unit. Low impedance in the fetoplacental circulation helps in a continuous forward flow in umbilical artery throughout the cardiac cycle [66].

An abnormal umbilical artery Doppler is defined as a PI, RI,or S/D ratio which is greater than the 95th percentile for that gestational age or having an absent or reversed end-diastolic velocity (AEDV or REDV).

Progression from decreased diastolic flow to an absent/ reversal in diastolic flow may take several days to weeks even in the absence of maternal disease.

Serial Umbilical artery doppler evaluation has resulted in a significant reduction in perinatal deaths. Hence it is now considered as an essential component of fetal surveillance in FGR [67, 68].

Progression to AEDF/REDF indicates significant placental deterioration and an associated high perinatal mortality.

A metaanalysis of 31 studies based on the risk of fetal death in FGR before 34 weeks of gestation reported odds ratios for fetal death of 3.59

and 7.27 for AEDV and REDV, respectively. Pooled data from this meta-analysis also revealed the risk of stillbirth of 6.8% for AEDV and 19% for REDV in the umbilical artery [69]. These risks of stillbirth are higher than the risk of infant mortality or severe morbidity at 33-34weeks for AEDV and at 30-32 weeks for REDV as reported in TRUFFLE [70].

It is recommended that once FGR is diagnosed, serial umbilical artery Doppler assessment should be performed to assess for any deterioration. This assessment initially has to be done every 1-2 weeks. If the umbilical artery Doppler remains normal after this initial assessment, a less frequent interval of testing (eg, every 2- 4 weeks) can be considered [71].

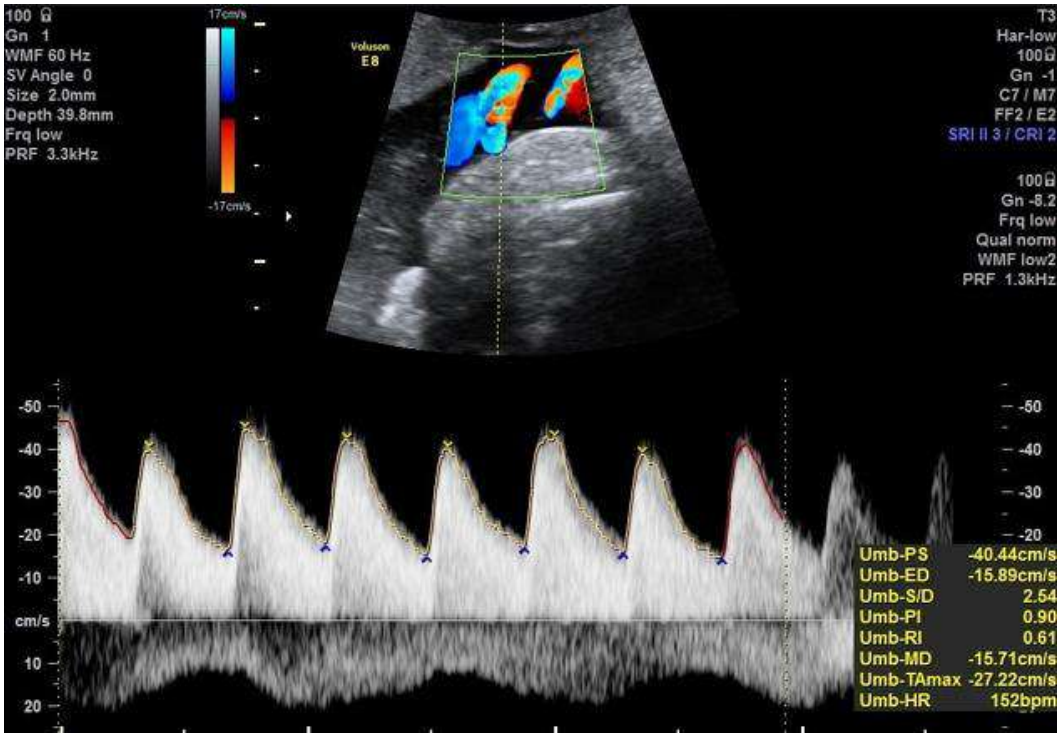


Figure 2.Normal umbilical artery assessment [72]

UMBILICAL ARTERY PI	5th centile	95th centile
26-28 weeks	0.87	1.21
28-32 weeks	0.82	1.15
32-36 weeks	0.71	1.04

References range for umbilical artery PI [73]

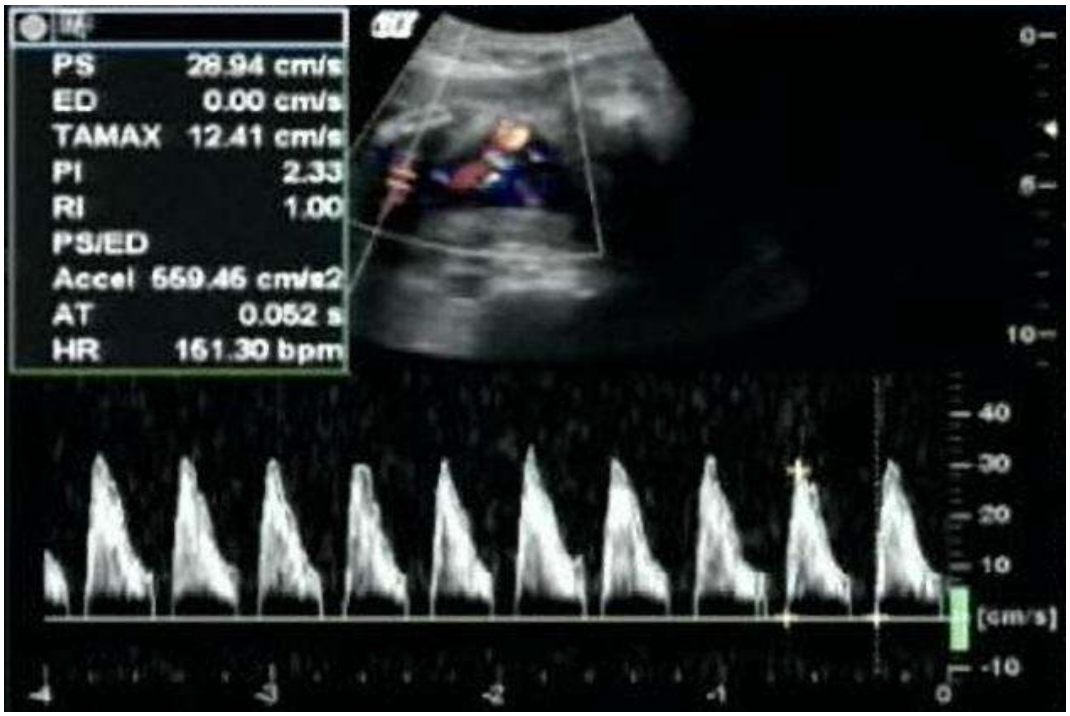


Figure3. Absent diastolic flow in umbilical artery in FGR [72]

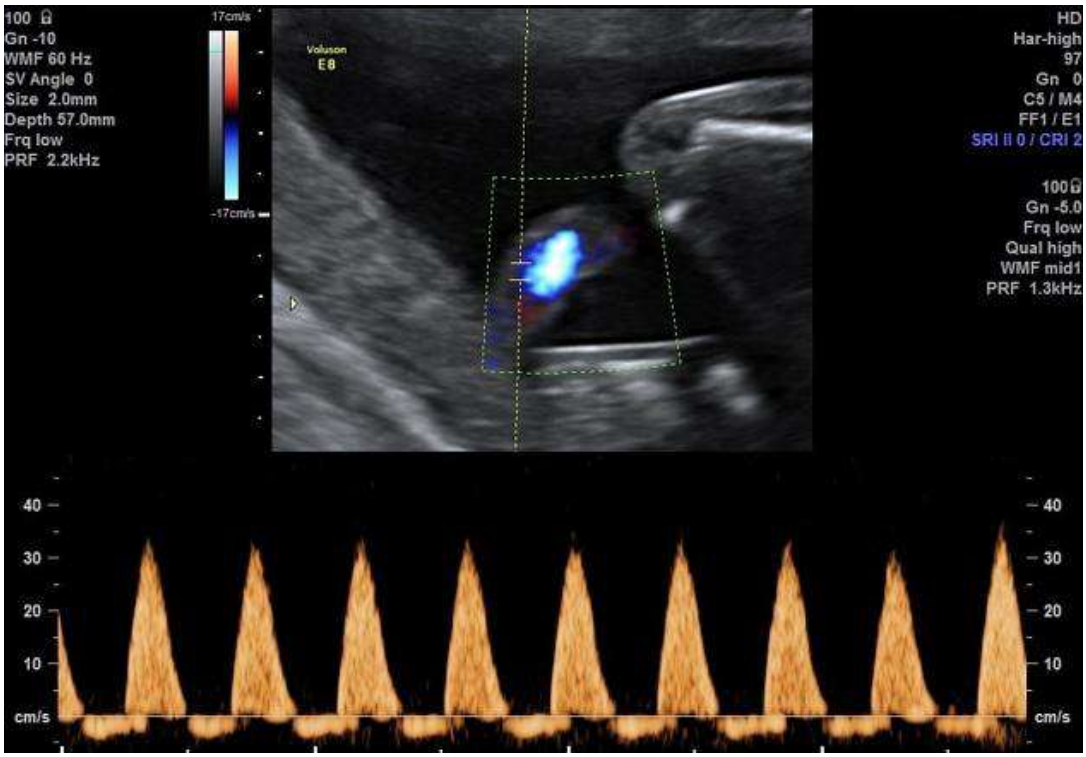


Figure 4. Reversal diastolic flow in umbilical artery in FGR [72].

Middle cerebral artery

Middle cerebral artery carries nearly 80percent of cerebral blood flow and is the largest vessel of fetal cerebral circulation [74].

Measurement of flow of blood through the middle cerebral artery identifies cerebral vasodilation, which can be quantified using PI or the cerebroplacental ratio (CPR) [75-78].

In a secondary analysis of data from TRUFFLE, middle cerebral artery Doppler did not provide any additional useful information beyond umbilical artery and ductus venosus Doppler assessment for optimizing the timing of delivery [79].

The Prospective Observational Trial to Optimize Pediatric Health in FGR (PORTO) studied the optimal management of fetuses with FGR between 24 0/7 to 36 6/7 weeks of gestation which included multivessel Doppler

measurement and CPR revealing that CPR evaluation had a sensitivity of 66%and specificity of 85% for the prediction of adverse perinatal outcomes[80].

MCA-PI	5^{th} centile	95^{th} centile
26-28 weeks	1.83	2.24
28-32 weeks	1.80	2.28
32-36 weeks	1.64	1.93

Reference range for MCA-PI [81].

Material and Methods

This is a prospective study conducted on 100 pregnant women >26 weeks period of gestation attending antenatal clinic or were admitted in department of obstetrics and gynecology, Dayanand medical college and hospital, Ludhiana which is a tertiary care hospital.

These patients would be subjected to USG fetal well- being and Doppler examination in Department of Radiodiagnosis, DMCH at 26-28 weeks, 28-32 weeks and 32-36 weeks gestation for assessment of fetal well- being and diagnosis of FGR.

All women being evaluated will undergo routine investigations and non-stress test for maternal and fetal surveillance.

Further these neonates will be followed up to 30 days after delivery and various parameters indicating fetal outcome will also be recorded.

Source of data

The study will be performed in the Department of Obstetrics and Gynecology, and Radiodiagnosis at Dayanand Medical College and Hospital, Ludhiana, which is a tertiary care hospital.

This will be a prospective study conducted on 100 pregnant women > 26 weeks gestation.

EXCLUSION CRITERIA:

- Twin / Multiple gestations.
- Congenital anomalies in baby.
- Extra uterine pregnancy.

METHOD OF COLLECTION OF DATA

The current study was conducted on 100 pregnant women who presented in Outpatient Department or were admitted in the antenatal ward of Department of Obstetrics and Gynecology, Dayanand Medical College and Hospital, Ludhiana. Pregnant women were recruited from 26 weeks of period of gestation.

The patient characteristics recorded were maternal age, parity, education, neonatal birth weight, gestational age at delivery, at each visit ultrasound fetal biometrics (AC) with estimated fetal weight (EFW) and doppler parameters. In addition to these patients were given standard antenatal care. Clinical parameter like Symphysio Fundal Height was measured from 26 weeks and was noted at each antenatal visit. Serial ultrasound doppler evaluation in uterine artery, umbilical artery and middle cerebral artery was done starting from 26 weeks onwards and followed till 36 weeks gestation.

The EFW was calculated according to the Hadlock formula. [82] Log 10 BW=1.326–0.00326 (AC) (FL) + 0.0107 (HC) + 0.0438 (AC) + 0.158 (FL).

Abdominal circumference was measured in the transverse plane at the level of fetal liver, with the umbilical portion of the left portal vein in the centre of the abdomen [83].

The Doppler Parameters were evaluated in the umbilical artery, uterine artery and middle cerebral artery, for the Uterine artery and Umbilical artery, a pulsatility index value >95th percentile was considered abnormal and Middle cerebral Artery pulsatile index <5th centile was considered abnormal [84].

Patients were followed up till delivery and neonates were followed till 30 days post-delivery. Maternal and fetal parameters including period of

gestation at delivery, mode of delivery, birth weight, sex of the fetus, NICU admission were noted.

Depending on the birth weight at the respective gestation and those patients with abnormal Doppler on antenatal ultrasound at any period of gestation, the diagnosis of true fetal growth restriction (FGR) was made if the birth weight was below the 10th percentile for that gestational age, in reference with growth percentile charts developed by Hadlock et al[85].

All the parameters were evaluated in patients as those with abnormal Doppler findings and the other group was with normal Doppler findings on antenatal ultrasound.

Maternal and fetal parameters were compared in both the groups.

Reference for Birth Weight according to gestational age [85]

26Weeks	740g	32 Weeks	1574g
27 Weeks	853g	33 Weeks	1740g
28 Weeks	978g	34 Weeks	1911g
29 Weeks	1114g	35 Weeks	2085g
30 Weeks	1260g	36 Weeks	2262g
31 Weeks	1414g	37 Weeks	2437g

OBSERVATION AND RESULTS

In our study, a total of 100 antenatal patients were recruited who attended antenatal clinic or were admitted in antenatal ward at DMCH, Ludhiana and were subjected to USG fetal well-being and Doppler in the Department Of Radiodiagnosis at 26-28 weeks, 28-32 weeks and 32-36 weeks gestation for assessment of fetal well-being and diagnosis of FGR.

A-MATERNAL CHARACTERISTICS

I-DEMOGRAPHIC PARAMETERS

1. AGE-

TABLE 1. DISTRIBUTION OF PATIENTS ACCORDING TO AGE GROUPS

Age group	No. of cases(n=100)	Percentage
< 25	23	23.0%
26-30	48	48.0%
> 30	29	29.0%
Total	100	100.0%

In our study out of 100 patients, 23 (23%) patients were of age group <25 years while 48 (48%) patients were of age group 26-30 years and 29 (29%) patients were of age group >30 years. The minimum age was 22 years while maximum age was 55 years and the mean age was 28.81 with standard deviation of 4.96.

FIGURE 5. DISTRIBUTION OF PATIENTS ACCORDING TO AGE GROUP.

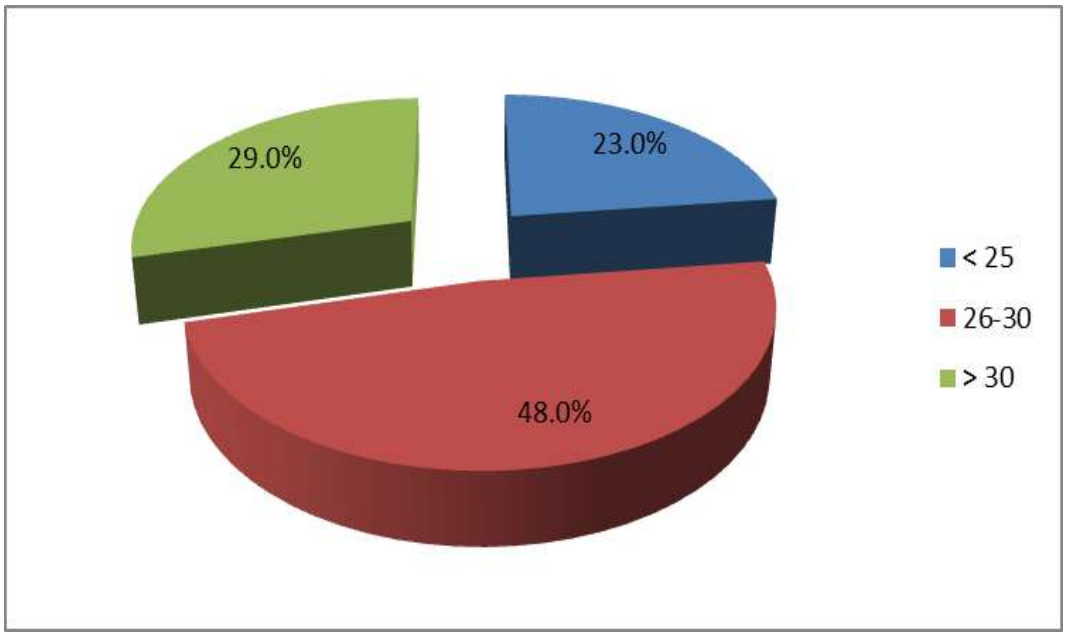


TABLE 2. DISTRIBUTION OF WOMEN UNDER STUDY ACCORDING TO PARITY

PARITY	No. of cases (n=100)	Percentage
Primigravida	64	64.0%
Multigravida	36	36.0%

In our study out of 100 patients, 64 (64%) were Primigravida and 36 (36%) were Multigravida.

FIGURE 6. DISTRIBUTION OF WOMEN ACCORDING TO PARITY

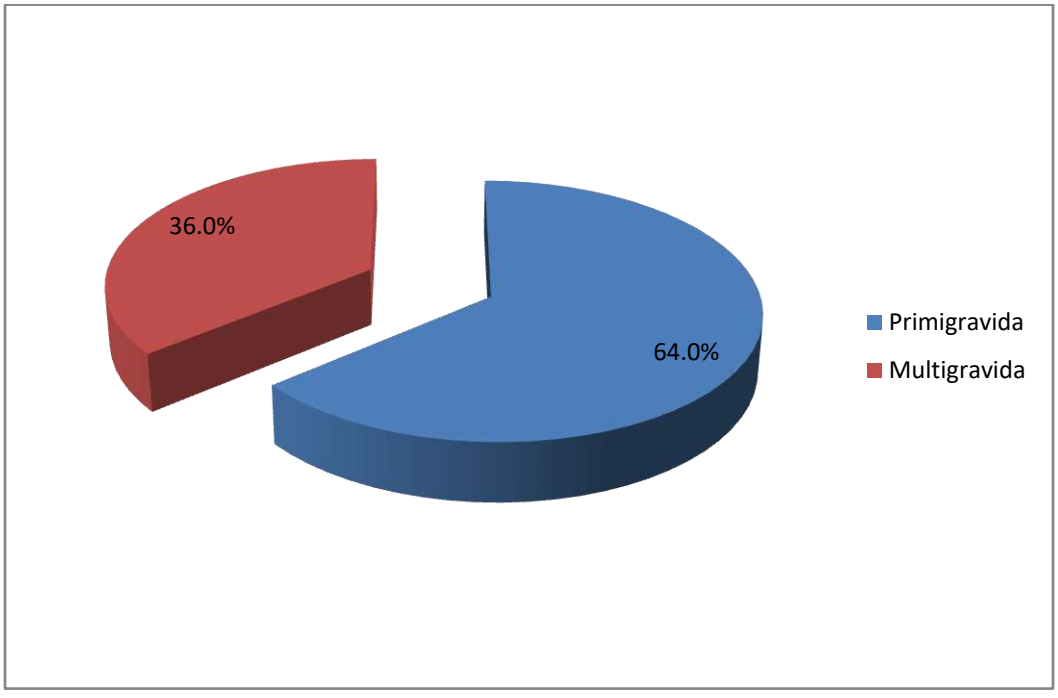


TABLE 3. DISTRIBUTION ACCORDING TO OCCUPATION

Occupation	No. of cases (n=100)	Percentage
Employed	56	56.0%
Unemployed	44	44.0%
Total	100	100.0%

In our study out of 100 patients, 56 (56%) were Employed and 44(44%) were Unemployed.

FIGURE 7. DISTRIBUTION OF WOMEN ACCORDING TO OCCUPATION

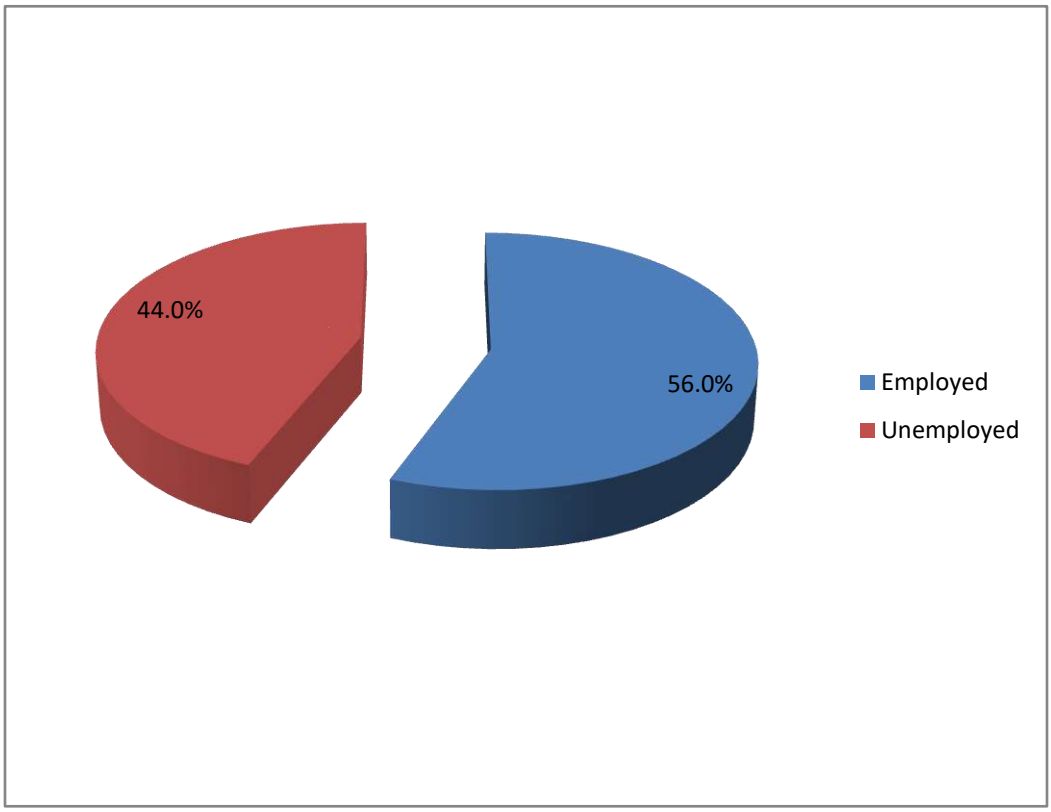


TABLE 4. DISTRIBUTION OF WOMEN ACCORDING TO RESIDENTIAL ADDRESS

Residential address	No. of cases (n=100)	Percentage
Rural	21	21.0%
Urban	79	79.0%
Total	100	100.0%

In our study out of 100 patients, 21(21%) belonged to Rural area while 79(79%) belonged to Urban area.

FIGURE 8. DISTRIBUTION OF WOMEN ACCORDING TO RESIDENTIAL ADDRESS

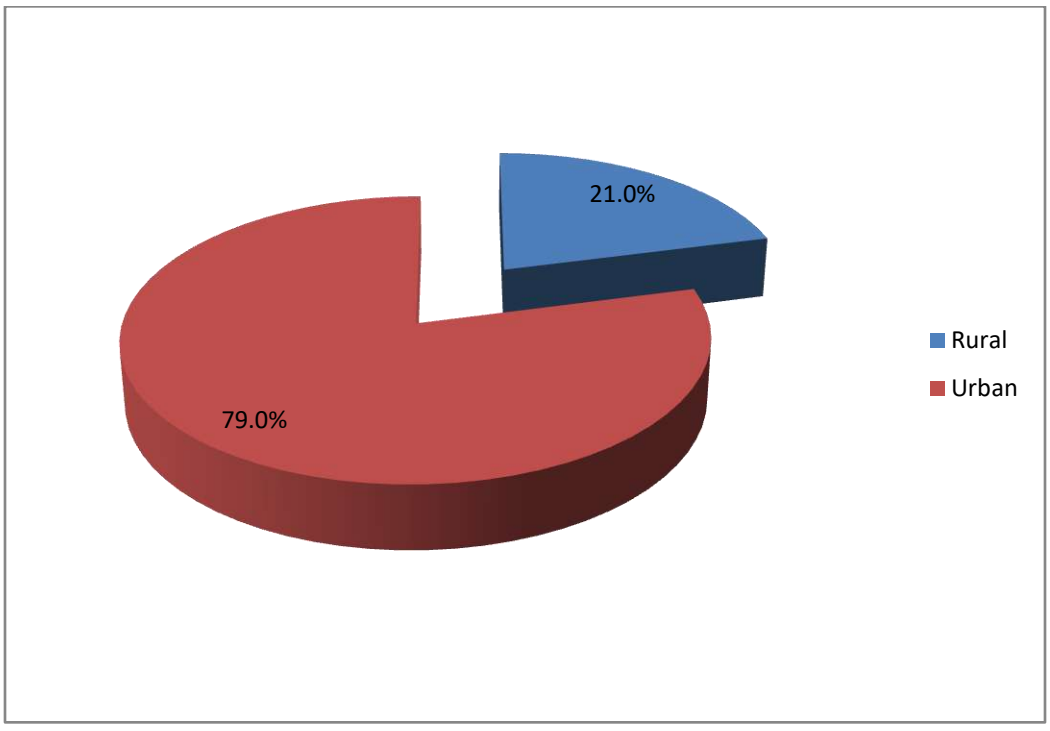


TABLE 5. DISTRIBUTION ACCORDING TO EDUCATION

Education	No. of cases(n=100)	Percentage
Graduate	60	60.0%
Postgraduate	19	19.0%
Undergraduate	21	21.0%
Total	100	100.0%

In our study out of 100 patients, 60 (60%) were Graduate while 21(21%) were Undergraduate and 19(19%) were Postgraduate.

FIGURE 9. DISTRIBUTION OF WOMEN ACCORDING TO EDUCATION

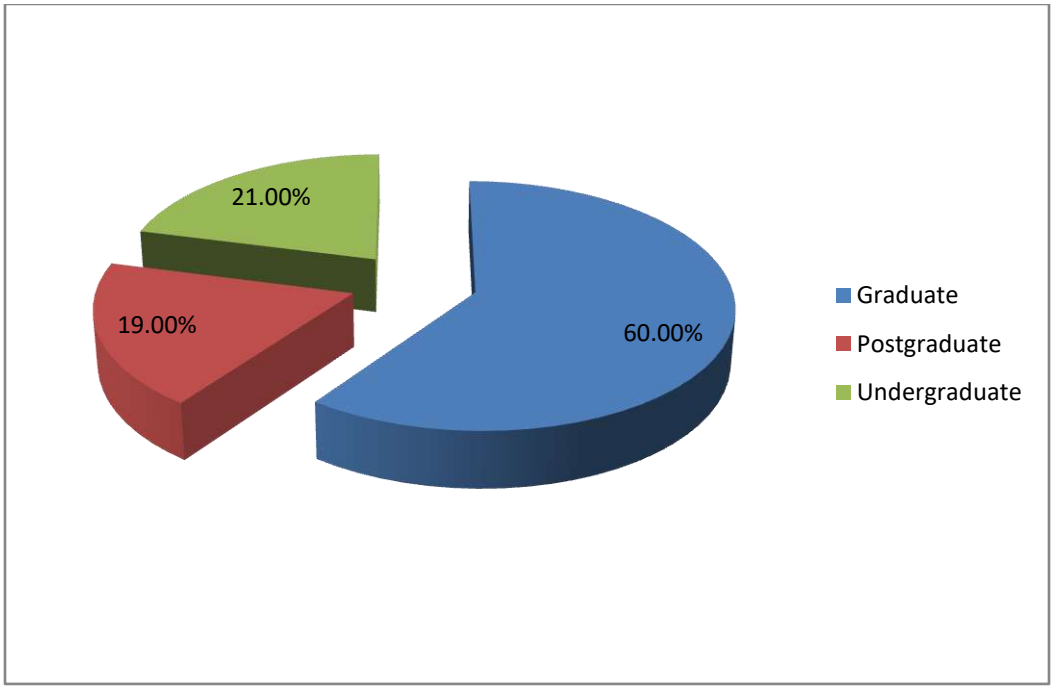


TABLE 6. DISTRIBUTION OF PATIENTS ACCORDING TO SYMPHYSIO FUNDAL HEIGHT

P/A : Fundal height	No. of cases(n=100)	Percentage
Not Corresponding	22	22.0%
Corresponding	78	78.0%
Total	100	100.0%

In our study out of 100 patients 78(78%) patients had SFH corresponding to period of gestation and 22(22%) patients had SFH not corresponding to period of gestation.

FIGURE 10. DISTRIBUTION ACCORDING TO SYMPHYSIO-FUNDAL HEIGHT

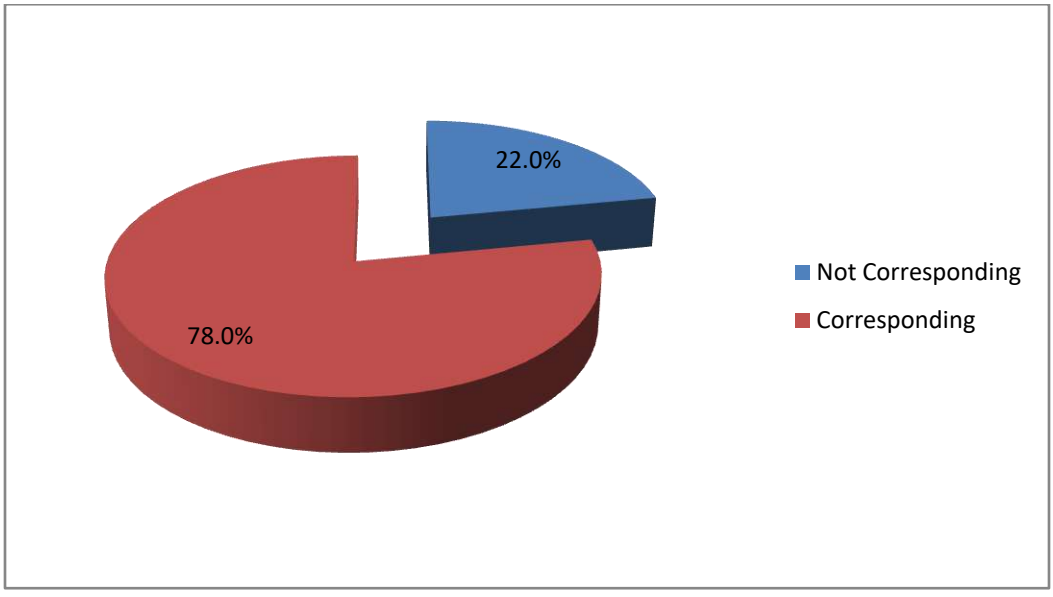


TABLE 7. DISTRIBUTION ACCORDING TO ABDOMINAL CIRCUMFERENCE

AC GROUP	No. of cases(n=100)	Percentage
>10th centile	48	48.0%
<10th centile	52	52.0%
Total	100	100.0%

	N	Minimum	Maximum	Mean	SD
AC	100	23.20	37.40	32.04	3.40

In our study out of 100 patients, 52(52%) patients had abdominal circumference <10th centile and 48(48%) patients had abdominal circumference >10th centile with a mean of 32.04 and standard deviation of 3.40.

FIGURE 11. DISTRIBUTION ACCORDING TO ABDOMINAL CIRCUMFERENCE

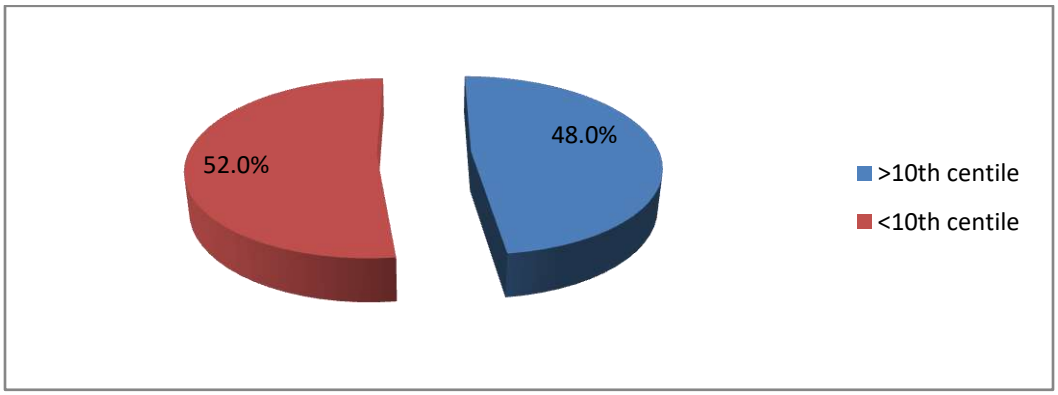


TABLE 8. Distribution of patients according to Ut-A PI at 26-28 weeks

26-28 weeks_Uterine Artery PI gp	No. of cases(n=100)	Percentage
< 95th centile	72	72.0%
> 95th centile	28	28.0%
Total	100	100.0%

In our study, Uterine Artery PI (<95th percentile and >95th percentile) was 72 (72%) and 28 (28%) respectively.

FIGURE 12. DISTRIBUTION ACCORDING TO Ut-A PI AT 26-28 WEEKS

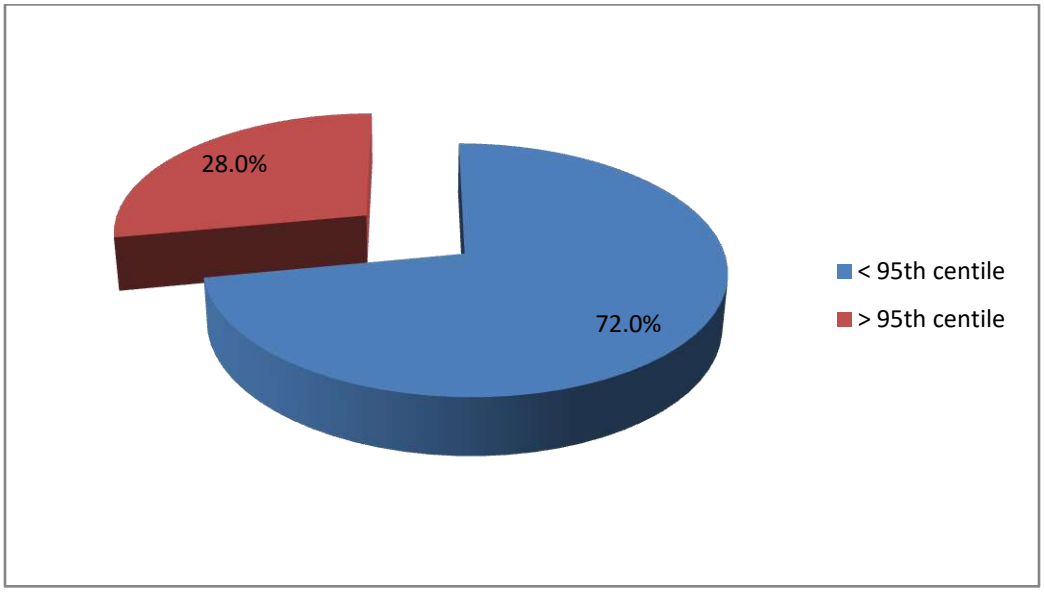


TABLE 9. Distribution of patients according to Umbilical Artery Pulsatility Index (UA-PI)

26-28 weeks_Umbilical Artery PI gp	No. of cases(n=100)	Percentage
< 95th centile	69	69.0%
> 95th centile	31	31.0%
Total	100	100.0%

In our study, Umbilical Artery PI (<95th percentile and >95th percentile) was 69(69%) and 31 (31%) respectively.

FIGURE 13. Distribution of patients according to Umbilical Artery Pulsatility Index (UA-PI)

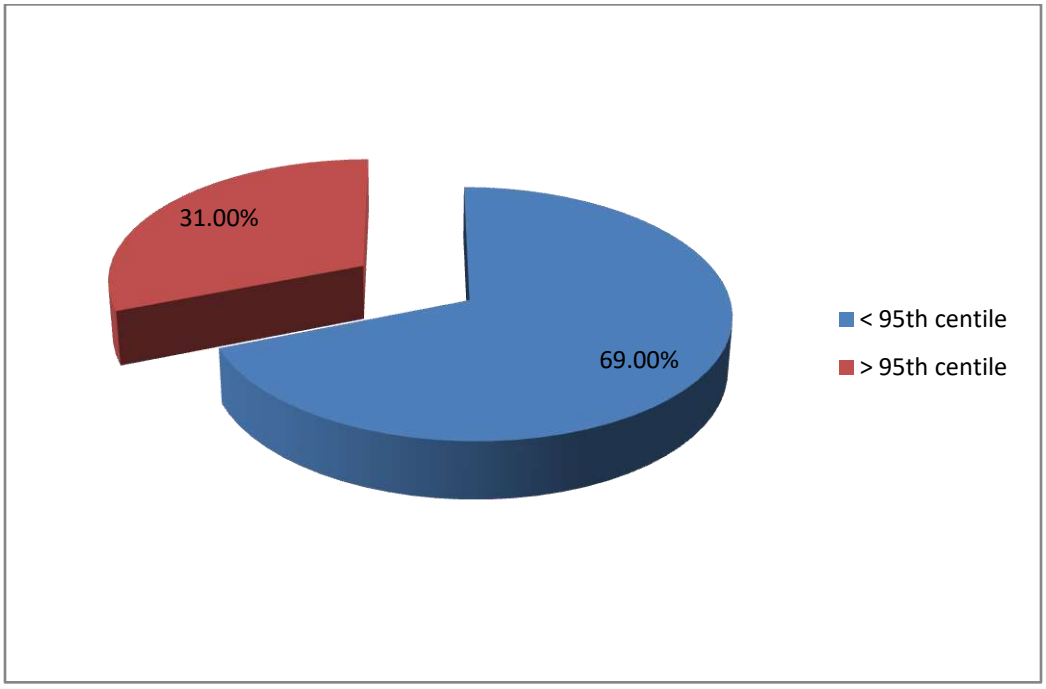


TABLE 10. Distribution of patients according to S/D ratio at 26-28 weeks

26-28 weeks_Umbilical Artery S/D gp	No. of cases(n=100)	Percentage
N	62	62.0%
Raised	31	31.0%
AEDF	5	5.0%
REDF	2	2.0%
Total	100	100.0%

In our study, Umbilical Artery S/D ratio was normal in 62(62%), raised in 31(31%), AEDF in 5(5%), REDF in 2(2%).

FIGURE 14. Distribution of patients according to S/D ratio at 26-28 weeks

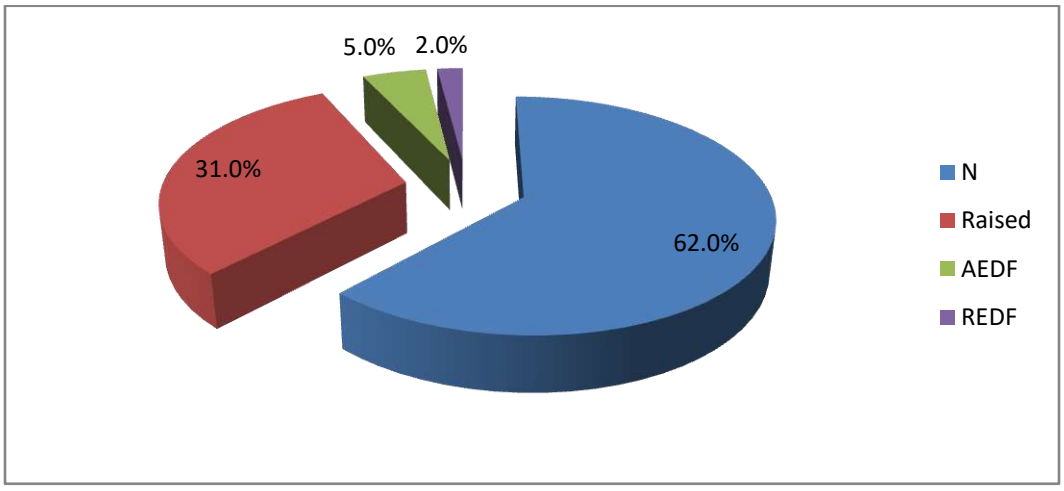


TABLE 11. Distribution of patients according to middle cerebral artery PI at 26-28 weeks

26-28 weeks_Middle Cerebral Artery PI	No. of cases(n=100)	Percentage
< 5th centile	15	15.0%
> 5th centile	85	85.0%
Total	100	100.0%

In our study of 100 patients, MCA-PI (<5th centile and >5th centile) was 15(15%) and 85(85%) respectively.

FIGURE 15. Distribution of patients according to middle cerebral artery PI at 26-28 weeks

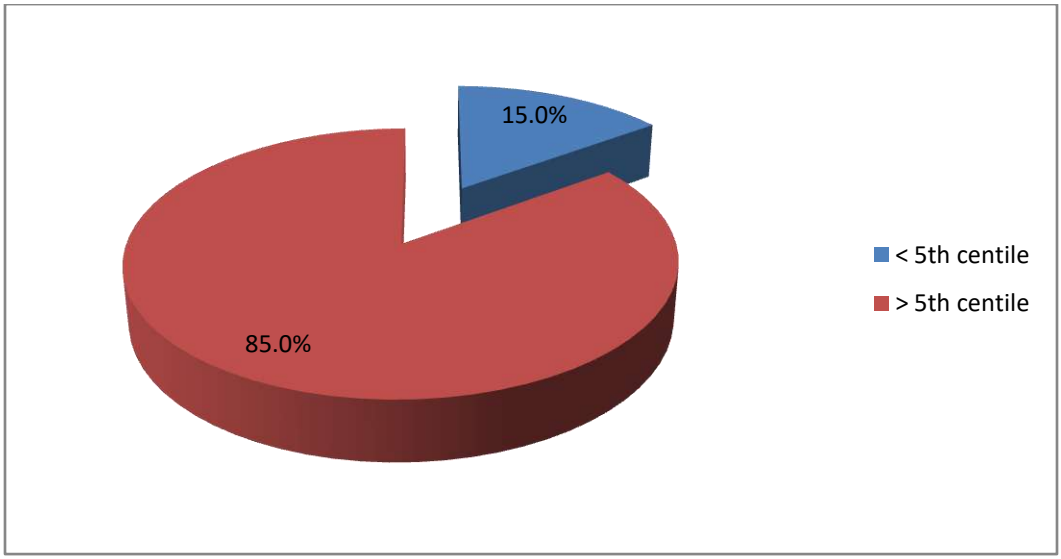


TABLE 12. Distribution of patients according to uterine artery PI at 28-32 weeks

28-32 weeks_Uterine Artery PI gp	No. of cases(n=91)	Percentage
< 95th centile	79	86.8%
> 95th centile	12	13.2%
Total	91	100.0%

In our study, Uterine Artery PI (<95th percentile and >95th percentile) was 79 (86.8%) and 12 (13.2%) respectively.

FIGURE 16. Distribution of patients according to uterine artery PI at 28-32 weeks

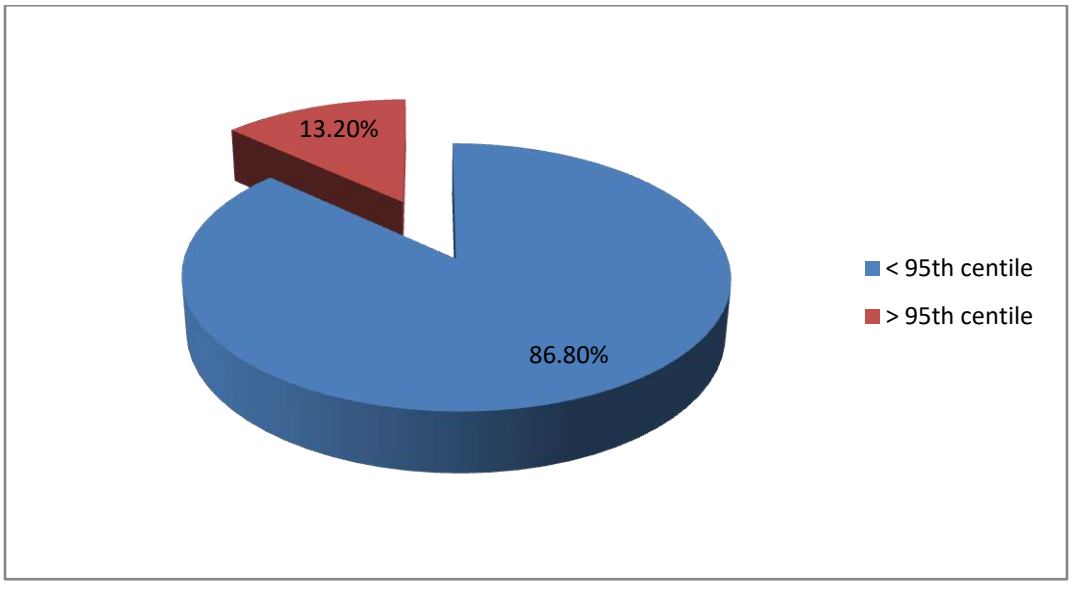


TABLE 13. Distribution of patients according to umbilical artery PI at 28-32 weeks

28-32 weeks_Umbilical Artery PI GP	No. of cases(n=91)	Percentage
< 95th centile	49	53.8%
> 95th centile	42	46.2%
Total	91	100.0%

In our study, Umbilical Artery PI (<95th percentile and >95th percentile) was 49(53.8%) and 42 (46.2%) respectively.

FIGURE 17. Distribution of patients according to umbilical artery PI at 28-32 weeks

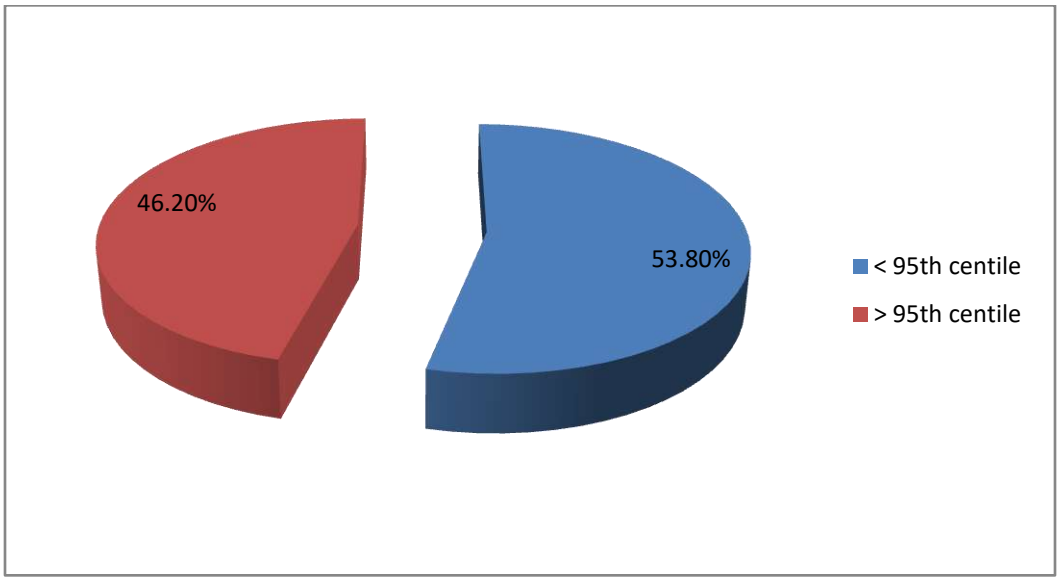


TABLE 14. Distribution of patients according to umbilical artery S/D ratio at 28-32 weeks

28-32 weeks_Umbilical Artery S/D gp	No. of cases(n=91)	Percentage
N	48	52.7%
Raised	38	41.8%
AEDF	3	3.3%
REDF	2	2.2%
Total	91	100.0%

In our study, Umbilical Artery S/D ratio was normal in 48(52.7%), raised in 38(41.8%), AEDF in 3(3.3%), REDF in 2(2.2%).

FIGURE 18. Distribution of patients according to umbilical artery S/D ratio at 28-32 weeks

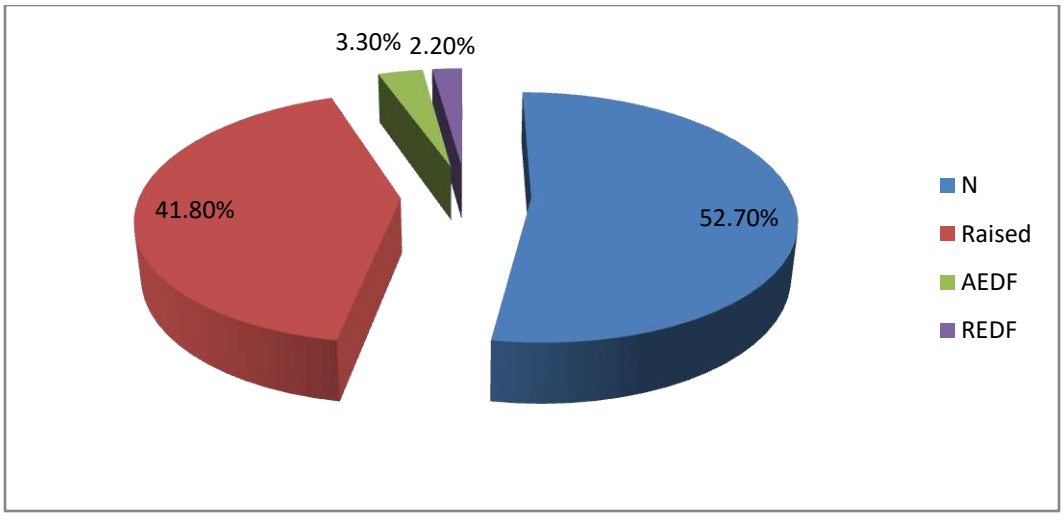


TABLE 15. Distribution of patients according to MCA-PI at 28-32 weeks

28-32 weeks_Middle Cerebral Artery PI GP	No. of cases(n=91)	Percentage
< 5th centile	22	24.2%
> 5th centile	69	75.8%
Total	91	100.0%

In our study of 100 patients, MCA-PI (<5th centile and >5th centile) was 22(24.2%) and 69(75.8%) respectively.

FIGURE 19. Distribution of patients according to MCA-PI at 28-32 weeks

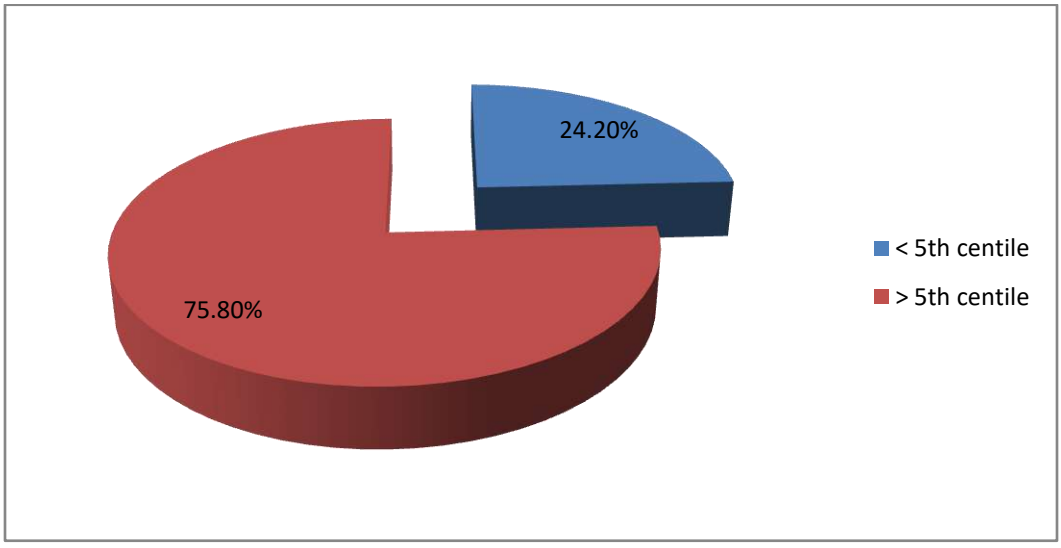


TABLE 16. Distribution of patients according to uterine artery PI at 32-36 weeks

32-36 weeks_Uterine Artery PI GP	No. of cases(n=63)	Percentage
< 95th centile	61	96.8%
> 95th centile	2	3.2%
Total	63	100.0%

In our study, Uterine Artery PI (<95th percentile and >95th percentile) was 61 (96.8%) and 2 (3.2%) respectively.

FIGURE 20. Distribution of patients according to uterine artery PI at 32-36 weeks

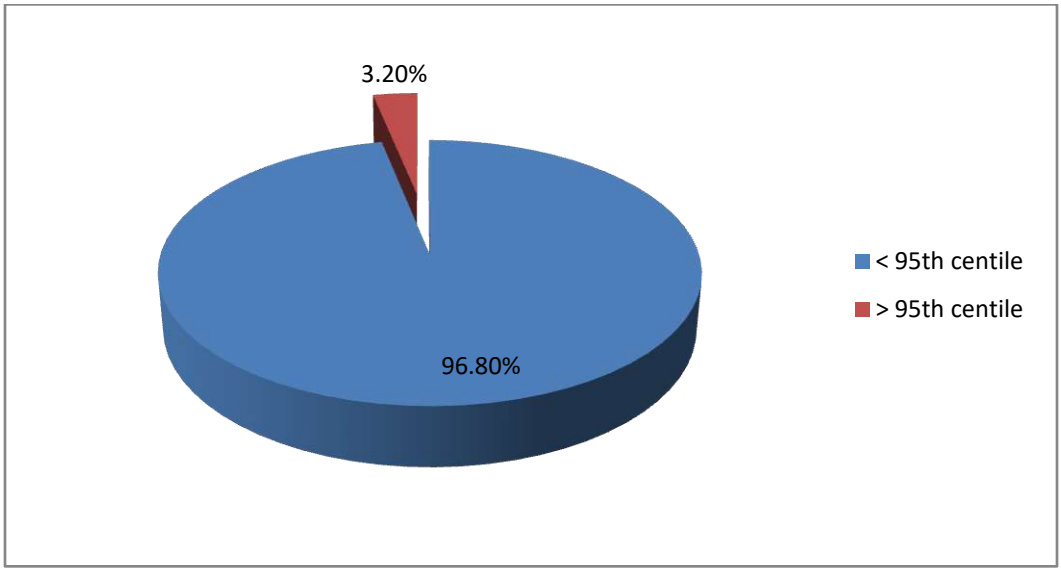


TABLE 17. Distribution of patients according to umbilical artery PI at 32-36 weeks

32-36 weeks_Umbilical Artery PI gp	No. of cases(n=63)	Percentage
< 95th centile	32	50.8%
> 95th centile	31	49.2%
Total	63	100.0%

In our study, Umbilical Artery PI (<95th percentile and >95th percentile) was 32(50.8%) and 31 (49.2%) respectively.

FIGURE 21. Distribution of patients according to umbilical artery PI at 32-36 weeks

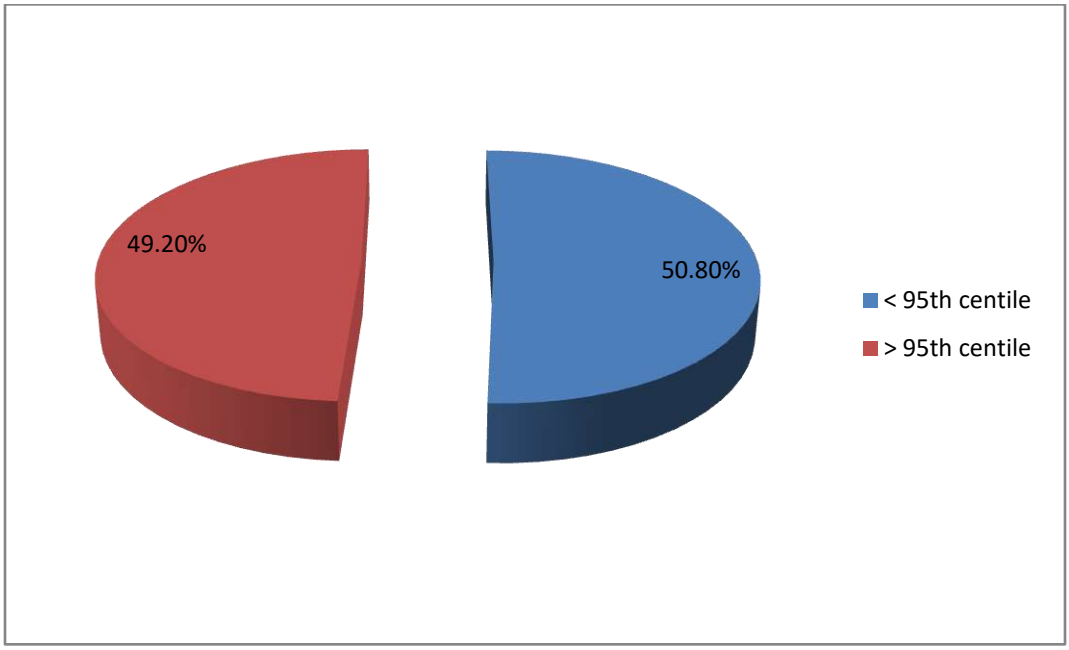


TABLE 18. Distribution of patients according to umbilical artery S/D at 32-36 weeks

32-36 weeks_Umbilical Artery S/D	No. of cases(n=63)	Percentage
N	32	50.8%
Raised	25	39.7%
AEDF	3	4.8%
REDF	3	4.8%
Total	63	100.0%

In our study, Umbilical Artery S/D ratio was normal in 32(50.8%), raised in 25(39.7%), AEDF in 3(4.8%), REDF in 3(4.8%).

FIGURE 22. Distribution of patients according to umbilical artery S/D at 32-36 weeks

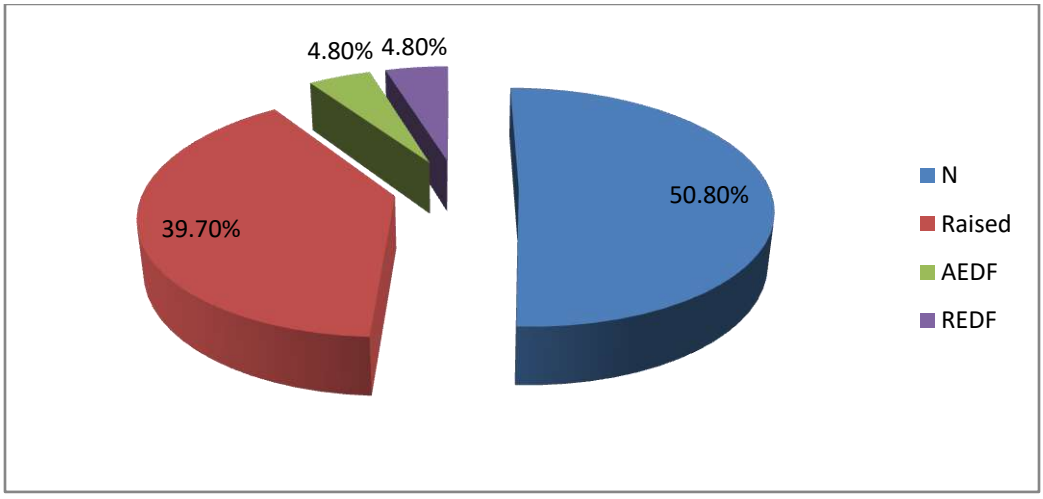


TABLE 19. Distribution of patients according to MCA-PI at 32-36 weeks

32-36 weeks_Middle Cerebral Artery PI GP	No. of cases(n=63)	Percentage
> 5th centile	35	55.6%
< 5th centile	28	44.4%
Total	63	100.0%

In our study of 100 patients, MCA-PI (<5th centile and >5th centile) was 35(55.6%) and 28(44.4%) respectively.

FIGURE 23. Distribution of patients according to MCA-PI at 32-36 weeks

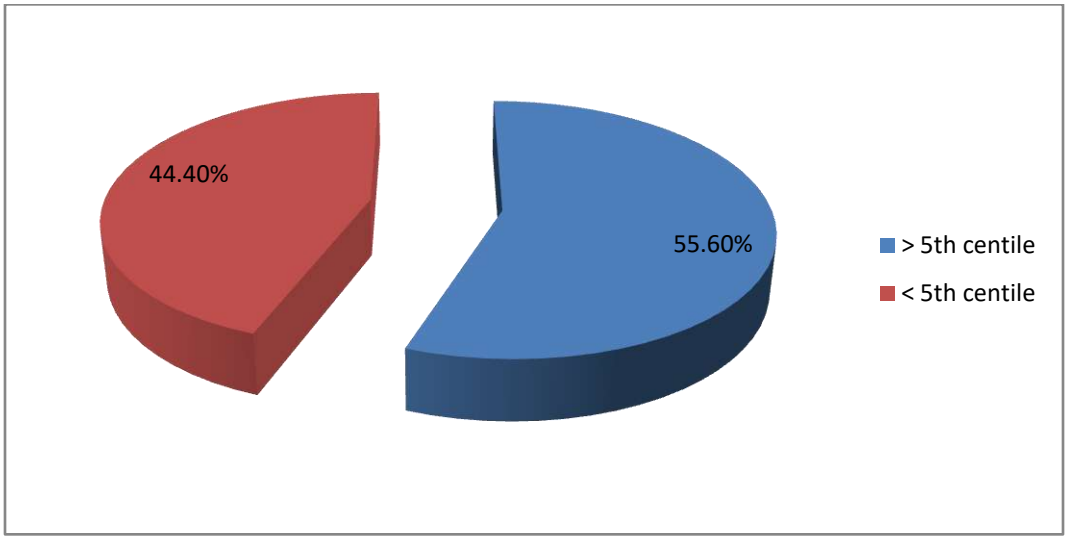


TABLE 20. Distribution of women according to the period of gestation at the time of delivery (weeks).

Period of gestation at the time of delivery gp	No. of cases(n=100)	Percentage
< 28	9	9.0%
28-32	28	28.0%
32-36	30	30.0%
> 37	33	33.0%
Total	100	100.0%

In our study of 100 patients, 9(9.0%) patients delivered before 28 weeks, 28(28.0%) patients delivered between 28-32 weeks, 30(30.0%) patients delivered between 32-36 weeks and 33(33.0%) patients delivered after 37 weeks. Majority of patients delivered after 37 weeks.

FIGURE 24. Distribution of women according to the period of gestation at the time of delivery (weeks).

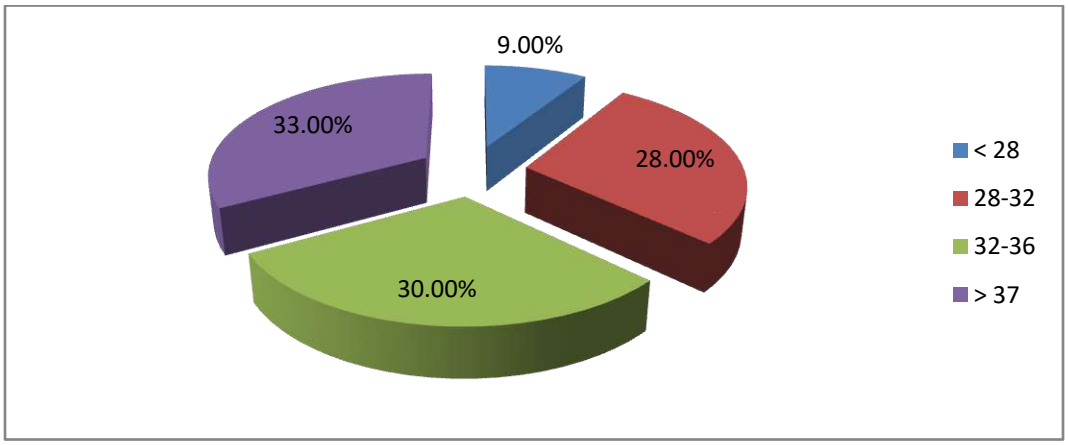


TABLE 21. Distribution of patients according to the mode of delivery

Mode of delivery	No. of cases(n=100)	Percentage
Cesarean	59	59.0%
Vaginal	41	41.0%
Total	100	100.0%

In our study of 100 patients, 59(59%) underwent caesarean delivery (LSCS) while 41(41%) patients delivered vaginally. Majority of the patients underwent caesarean delivery (LSCS).

FIGURE 25. Distribution of patients according to the mode of delivery

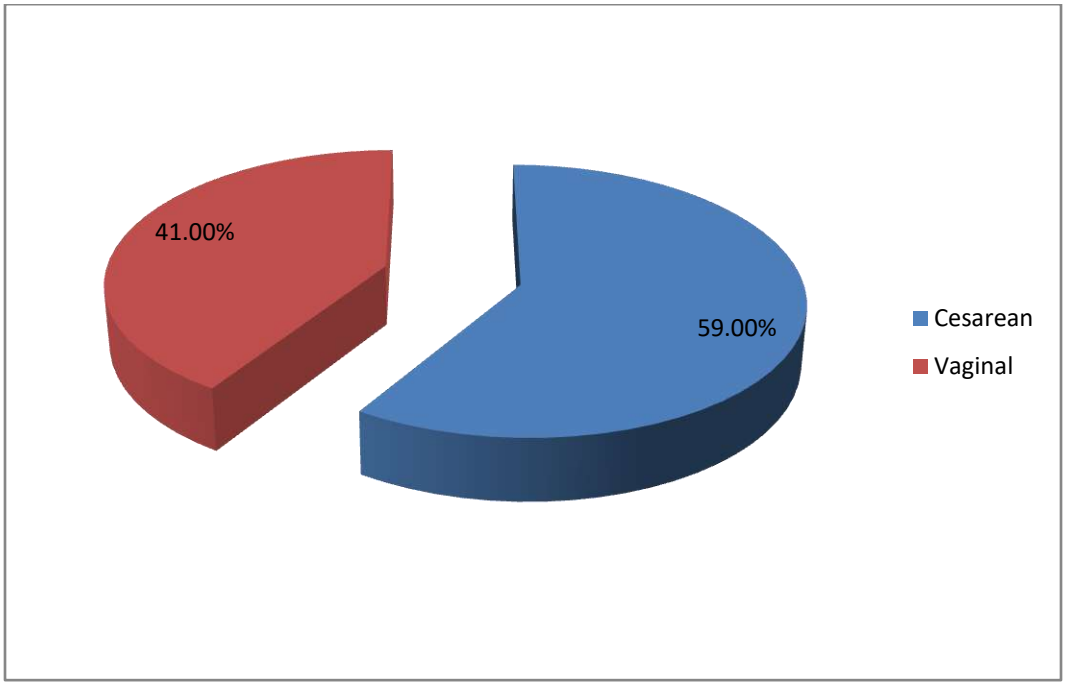


TABLE 22: Distribution of women under study according to the baby weight (kg).

Birth weight(kg) gp	No. of cases(n=100)	Percentage
>10th centile	37	37.0%
<10th centile	63	63.0%
Total	100	100.0%

In our study, birth weight was <10th centile in 63(63.0%) babies and >10th centile in 33(33.0%) babies. Majority of babies had birth weight <10th centile according to period of gestation at which they delivered.

FIGURE 26. Distribution of women under study according to the birth weight (kg).

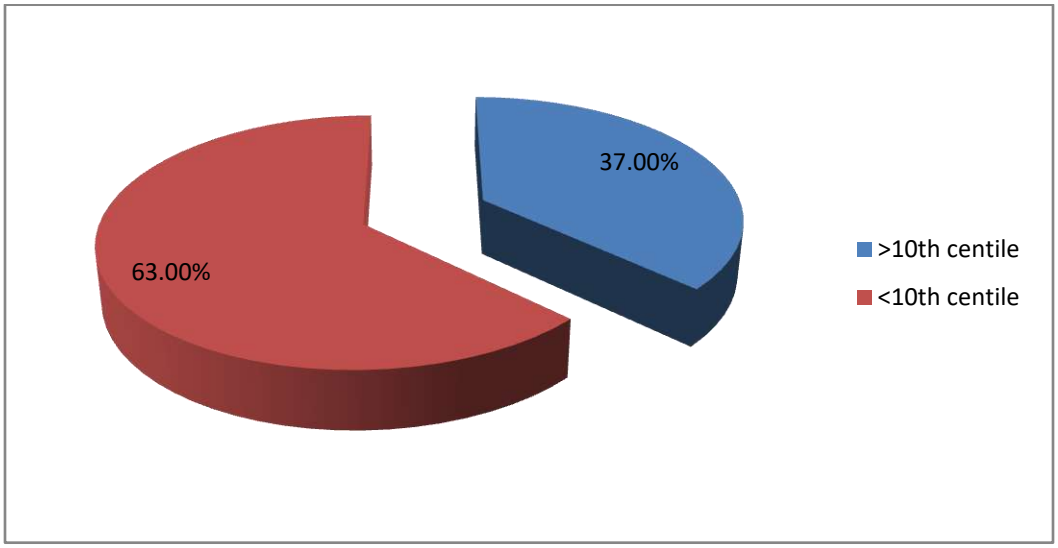


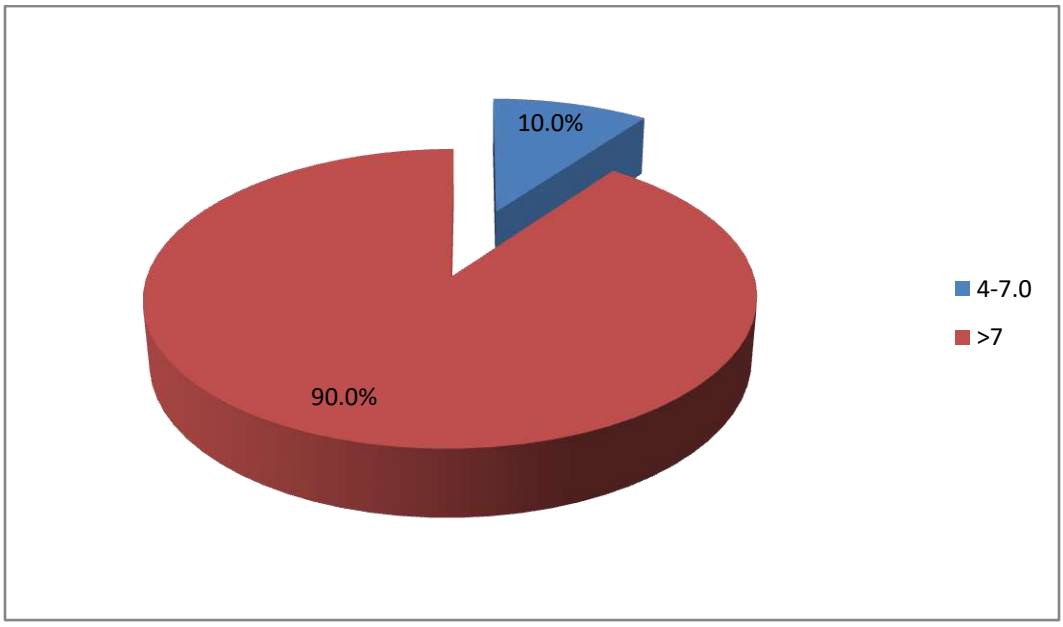
TABLE 23. Distribution of babies according to the Apgar score at 1 min and 5 min of birth.

APGAR SCORE AT 1 MINS GP	No. of cases(n=100)	Percentage
4-7.0	10	10.0%
>7	90	90.0%
Total	100	100.0%

APGAR SCORE AT 5 MINS GP	No. of cases(n=100)	Percentage
>7	90	90.0%
<7	10	10.0%

In our study out of 100 babies, APGAR score at 1 min was between 4-7 and >7 in 10(10.0%) babies and 90(90.0%) babies and APGAR score at 5 min was >7 in 100(90.0%) babies and <7 in 10(10.0%) babies.

FIGURE 27. Distribution of babies according to the Apgar score at 1 min and 5 min of birth.



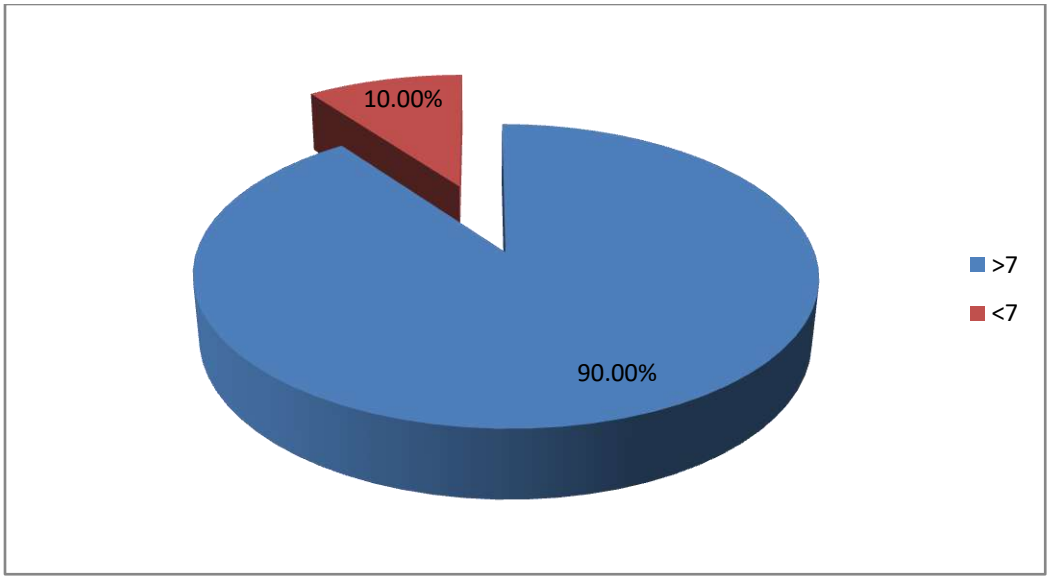


TABLE 24. Distribution of patients according to NICU admission

Admisssion to NICU	No. of cases(n=100)	Percentage
No	42	42.0%
Yes	58	58.0%
Total	100	100.0%

In our study, 58(58%) babies had NICU admissions while 42(42%) babies did not require NICU admissions.

FIGURE 28. Distribution of patients according to NICU admission

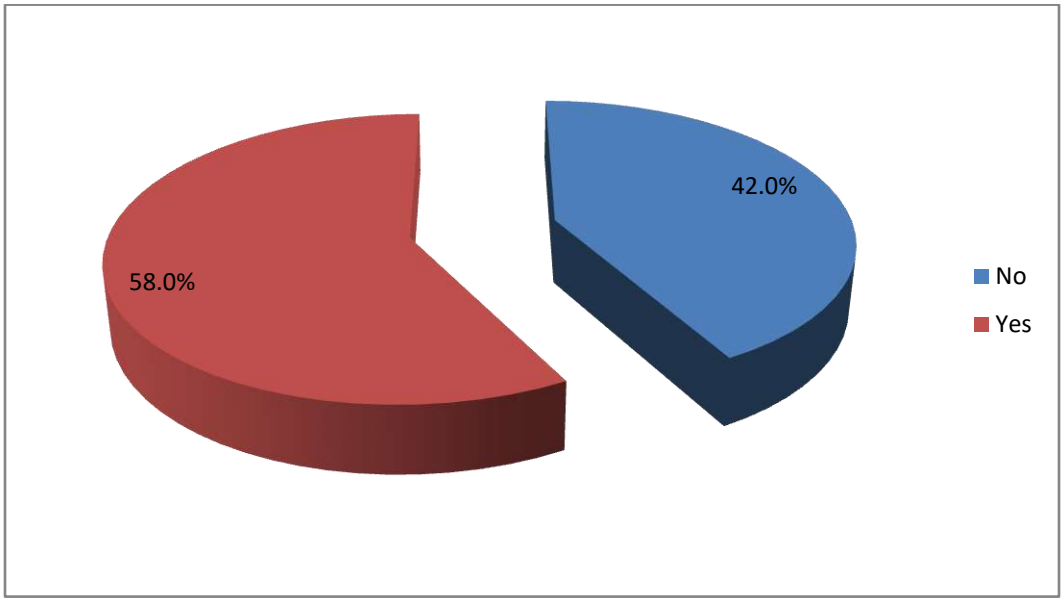


TABLE 25. Distribution of babies according to Maturity

Gestation	No. of cases(n=100)	Percentage
Preterm	67	67.0%
Term	33	33.0%
Total	100	100.0%

In our study of 100 babies, 67(67%) babies were born preterm (<37weeks) while 33(33%) babies were born at term (>37 weeks).

FIGURE 29.Distribution of babies according to Maturity

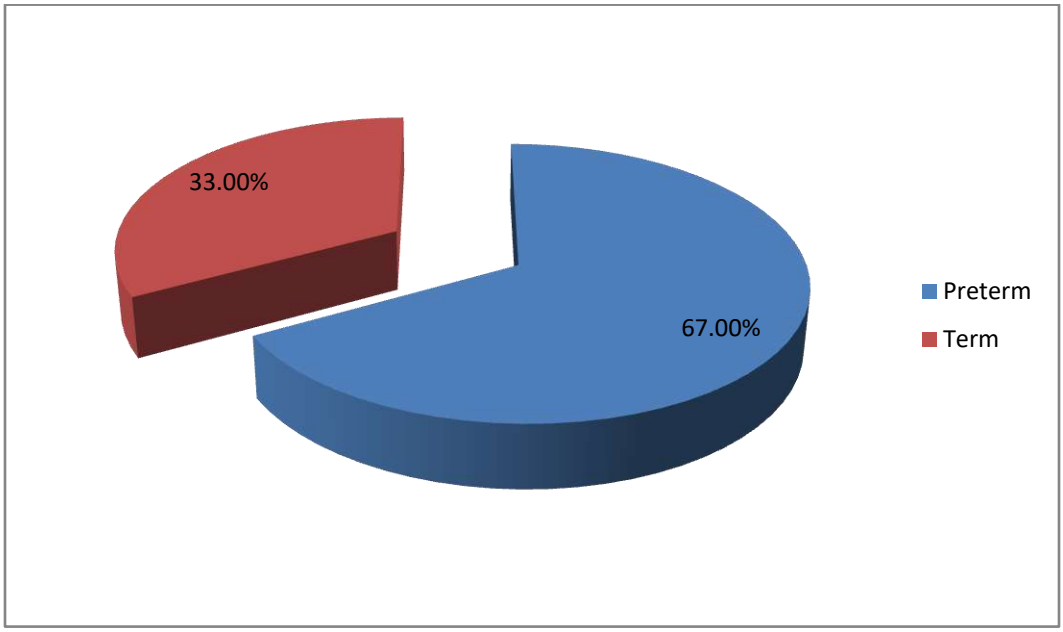


TABLE 26. Distribution of babies according to indication of NICU admission (n=58)

Prematurity	No. of cases	Percentage
Prematurity	48	82.8%
ABN Doppler	39	67.2%
Increased rates of breathing	4	6.9%

In our study 48(82.8%) babies were admitted in NICU i/v/o prematurity, 39(67.2%) babies were admitted to NICU i/v/o abnormal doppler and 4(6.9%) babies admitted i/v/o increased rates of breathing.

FIGURE 30. Distribution of babies according to indication of NICU admission (n=58)

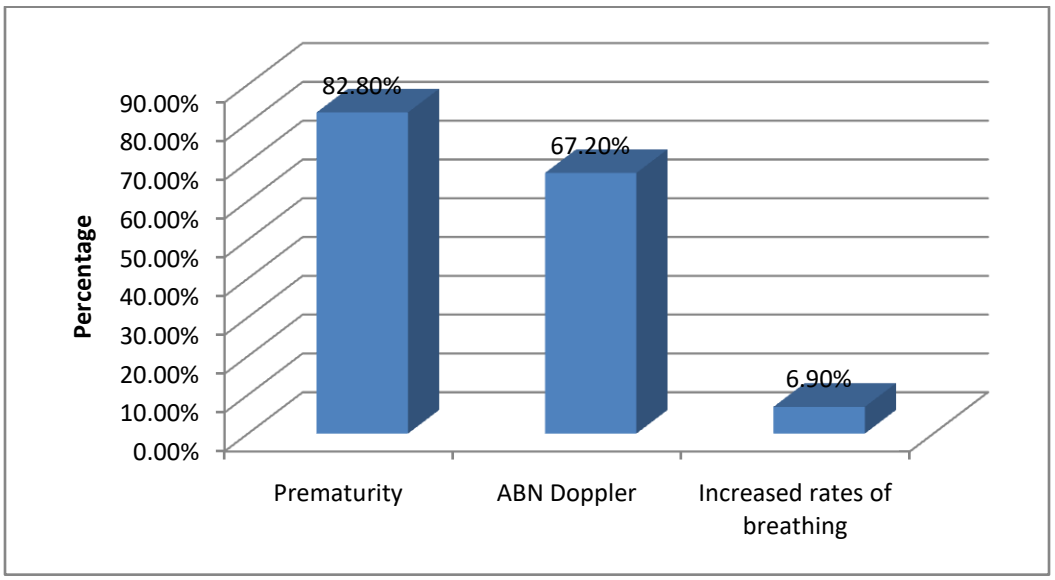


TABLE 27. Distribution of babies according to Neonatal Outcome

Neonatal Outcome	No. of cases	Percentage
Live Birth	100	100.0%
Neonatal Deaths	8	8.0%
Total	100	100.0%

In our study of 100 babies, 100(100%) babies were born live while there were 8(8%) neonatal deaths out of which 1(1%) had an early neonatal death (<7 days) and 7(7%) babies had late neonatal death (>7 days).

FIGURE 31. Distribution of babies according to Neonatal Outcome

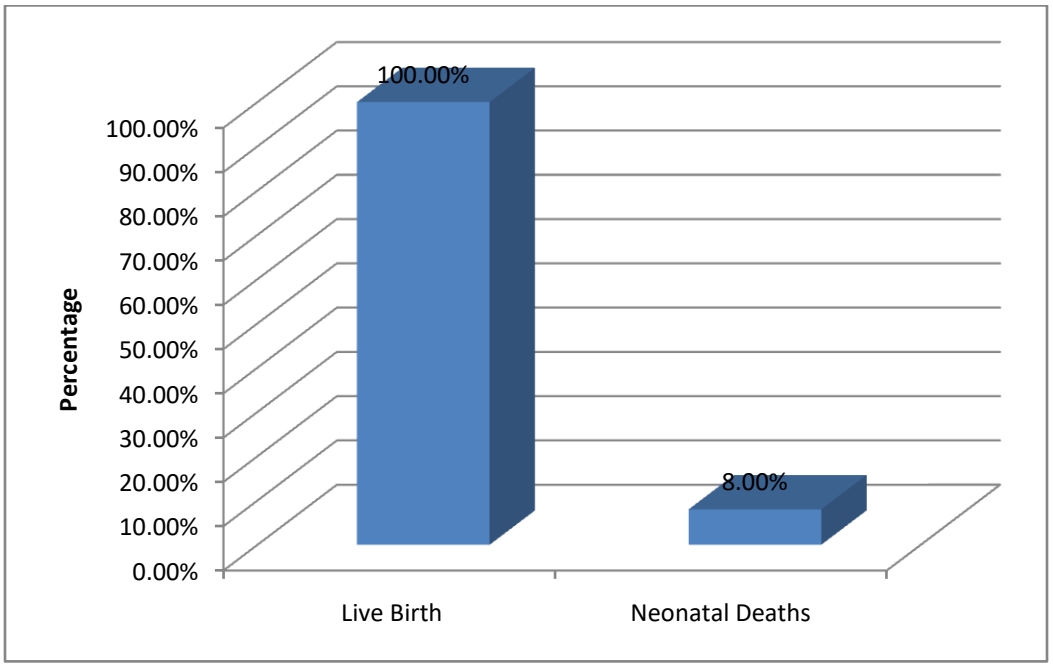


TABLE 28. Distribution of babies according to adverse perinatal outcome.

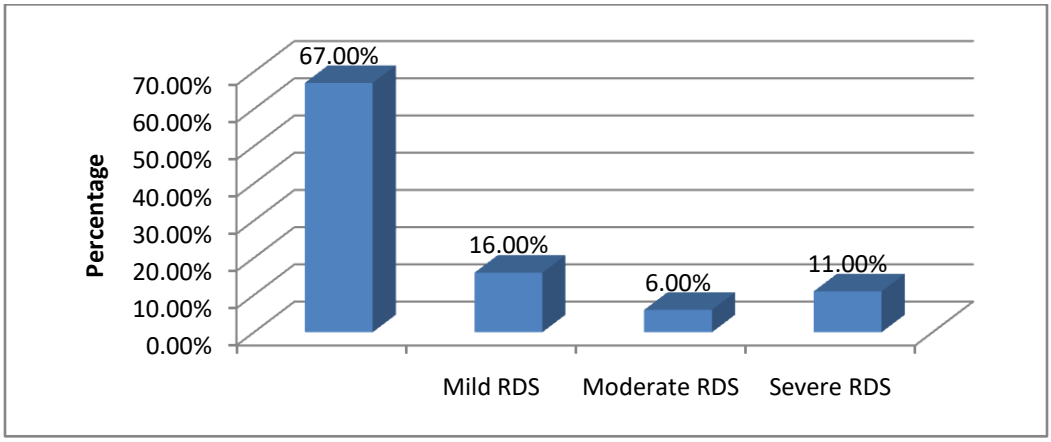
Perinatal complications RDS	No. of cases(n=100)	Percentage
	67	67.0%
Mild RDS	16	16.0%
Moderate RDS	6	6.0%
Severe RDS	11	11.0%
Total	100	100.0%

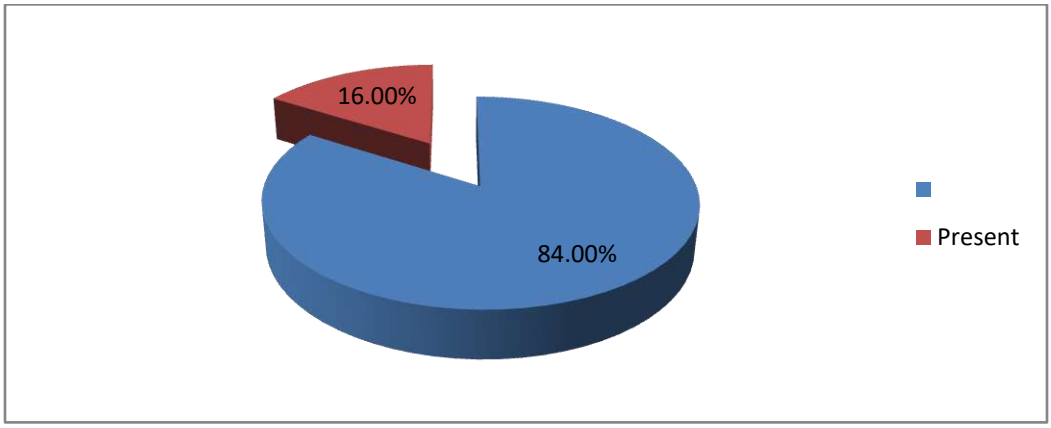
NEONATAL HYPERBILIRUBINEMIA	No. of cases(n=100)	Percentage
	84	84.0%
Present	16	16.0%
Total	100	100.0%

NEC	No. of cases(n=100)	Percentage
	86	86.0%
NEC IIB	1	1.0%
NEC-I	13	13.0%
Total	100	100.0%

In our study of 100 babies, perinatal complications like RDS present in 33(33%) babies, neonatal hyperbilirubinemia seen in 16(16%) babies and NEC present in 14(14%) babies.

FIGURE 32. Distribution of babies according to adverse perinatal outcome.





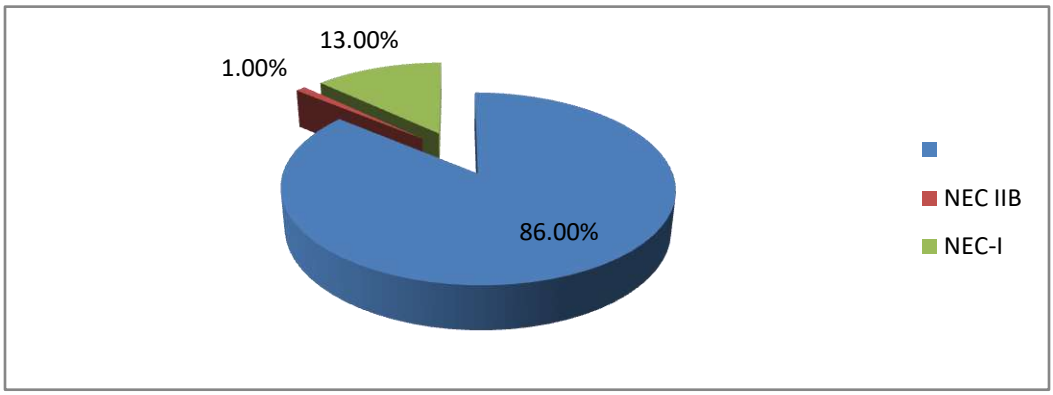


TABLE 29. Age wise distribution between patients with normal and abnormal Doppler

		Normal		Abnormal		Total	Chi-square value	p-value
USG Doppler Evaluation done at POG(weeks)	AGE	No. of cases	%age	No. of cases	%age			
26-28	< 25	11	24.4%	12	21.8%	23	0.096	0.756
	26-30	22	48.9%	26	47.3%	48	0.026	0.872
	> 30	12	26.7%	17	30.9%	29	0.216	0.641
Total		45	100.0%	55	100.0%	100	0.241	0.886
28-32	< 25	8	22.9%	14	25.0%	22	0.054	0.816
	26-30	17	48.6%	28	50.0%	45	0.017	0.894
	> 30	10	28.6%	14	25.0%	24	0.038	0.846
Total		35	100.0%	56	100.0%	91	0.154	0.926
32-36	< 25	7	25.9%	8	22.2%	15	0.117	0.733
	26-30	15	55.6%	20	55.6%	35	0.001	1.000
	> 30	5	18.5%	8	22.2%	13	0.129	0.719
Total		27	100.0%	36	100.0%	63	0.191	0.909

a) Between 26-28 weeks POG

In our study, 11(24.4%) vs 12(21.8%) were <25 years of age in patients with normal and abnormal Doppler respectively with p value 0.756 which is statistically insignificant.

Twenty two (48.9%) vs twenty six (47.3) patients belonged to age group 26-30 years in patients with normal and abnormal Doppler respectively with p value 0.872 which is statistically insignificant.

Twelve (26.7%) vs seventeen (30.9%) patients belong to age >30 years in patients with normal and abnormal Doppler respectively with p value 0.641 which is statistically insignificant.

Majority of patients belonged to age group of 26-30 years.

b) Between 28-32 weeks

In our study, 8(22.9%) vs 14(25%) were <25 years of age in patients with normal and abnormal Doppler respectively with p value 0.816 which is statistically insignificant.

17 (48.6%) vs 28 (50.0%) patients belonged to age group 26-30 years in patients with normal and abnormal Doppler respectively with p value 0.894 which is statistically insignificant.

10(28.6%) vs 14 (25.0%) patients belong to age >30 years in patients with normal and abnormal Doppler respectively with p value 0.846 which is statistically insignificant.

Majority of patients belonged to age group of 26-30 years.

c) Between 32-36 weeks POG

In our study, 7(25.9%) vs 8(22.2%) were <25 years of age in patients with normal and abnormal Doppler respectively with p value 0.733 which is statistically insignificant.

15 (55.6%) vs 20 (55.6%) patients belonged to age group 26-30 years in patients with normal and abnormal Doppler respectively with p value 1.000 which is statistically insignificant.

5(18.5%) vs 8 (22.2.0%) patients belong to age >30 years in patients with normal and abnormal Doppler respectively with p value 0.719 which is statistically insignificant.

Majority of patients belonged to age group of 26-30 years.

FIGURE 33. Age wise distribution between patients with normal and abnormal doppler

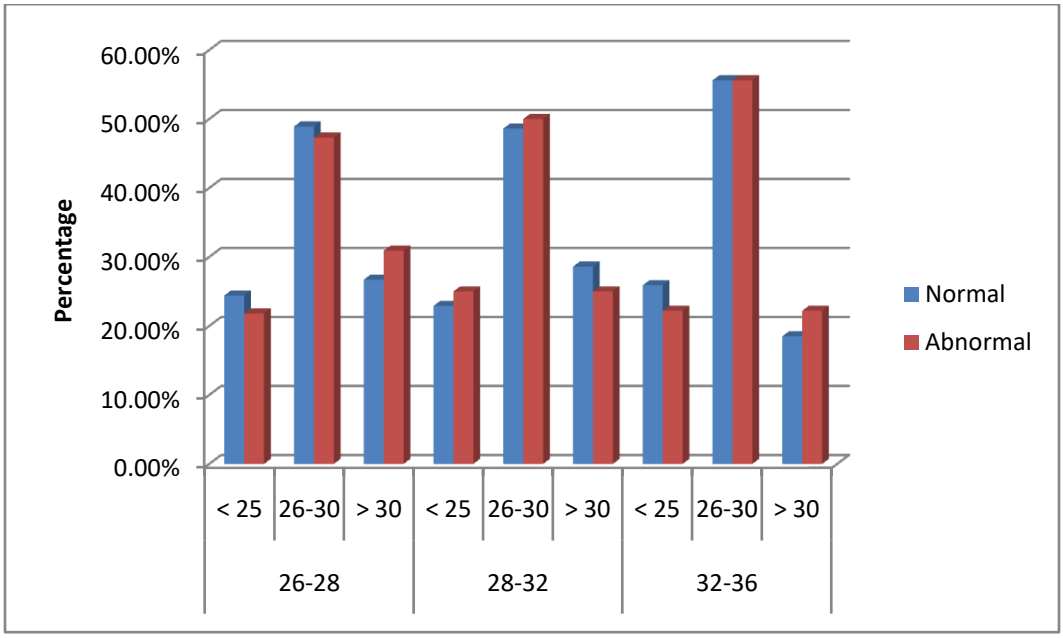


TABLE 30. Comparison of women according to parity between patients having normal and abnormal Doppler

		Normal		Abnormal		Total	Chi-square value	p-value
USG Doppler Evaluation done at POG(weeks)	Parity	No. of cases	%age	No. of cases	%age			
26-28	Multi	14	31.1%	22	40.0%	36	0.849	0.357
	Primi	31	68.9%	33	60.0%	64		
Total		45	100.0%	55	100.0%	100		
28-32	Multi	12	34.3%	22	39.3%	34	0.23	0.631
	Primi	23	65.7%	34	60.7%	57		
Total		35	100.0%	56	100.0%	91		
32-36	Multi	9	33.3%	12	33.3%	21	0.001	1.000
	Primi	18	66.7%	24	66.7%	42		
Total		27	100.0%	36	100.0%	63		

a) Between 26-28 weeks

In our study, 14(31.1%) patients were multigravida having normal Doppler while 22(40%) patients were multigravida having abnormal Doppler.

31(68.9%) patients were primigravida having normal Doppler while 33(60%) patients were primigravida having abnormal Doppler with a p value of 0.357 which is statistically insignificant.

b) Between 28-32 weeks

In our study, 12(34.3%) patients were multigravida having normal Doppler while 22(39.3%) patients were multigravida having abnormal Doppler.

23(65.7%) patients were primigravida having normal Doppler while 34(60.7%) patients were primigravida having abnormal Doppler with a p value of 0.631which is statistically insignificant.

c) Between 32-36 weeks

In our study, 9(33.3%) patients were multigravida having normal Doppler while 12(33.3%) patients were multigravida having abnormal Doppler.

18(66.7%) patients were primigravida having normal Doppler while 24(66.7%) patients were primigravida having abnormal Doppler with a p value of 1.000 which is statistically insignificant.

FIGURE 34. COMPARISON OF WOMEN ACCORDING TO PARITY BETWEEN PATIENTS HAVING NORMAL AND ABNORMAL DOPPLER.

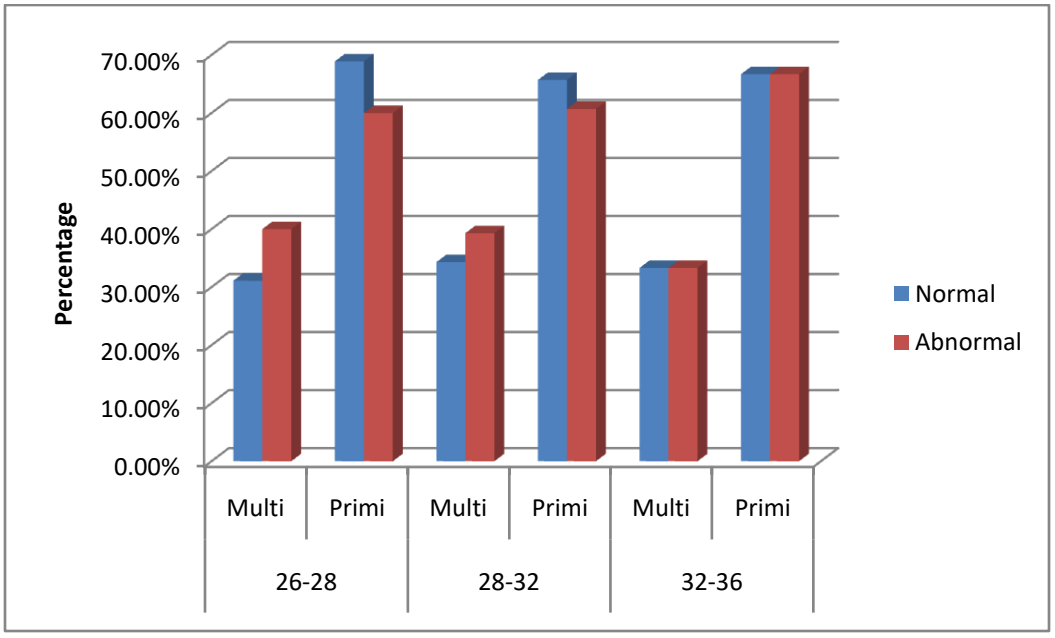


TABLE 31. DISTRIBUTION OF WOMEN UNDER STUDY ACCORDING TO OCCUPATION

		Normal		Abnormal		Total	Chi-square value	p-value
USG Doppler Evaluation done at POG(weeks)	**Occupation**	No. of cases	%age	No. of cases	%age			
26-28	Employed	24	0.0%	32	1.8%	56	0.992	0.609
	Housewife	21	46.7%	23	41.8%	44		
Total		45	100.0%	55	100.0%	100		
28-32	Employed	17	0.0%	35	1.8%	52	2.167	0.338
	Housewife	18	51.4%	21	37.5%	39		
Total		35	100.0%	56	100.0%	91		
32-36	Employed	14	51.9%	21	58.3%	35	0.263	0.608
	Housewife	13	48.1%	15	41.7%	28		
Total		27	100.0%	36	100.0%	63		

a) Between 26-28 weeks

In our study, 24(53.3%) patients were employed having normal Doppler whereas 32(56.4%) patients were employed having abnormal Doppler.

21(46.7%) patients were unemployed having normal Doppler whereas 23(41.8%) patients were unemployed having abnormal Doppler with a p value of 0.609 which is statistically insignificant.

b) Between 28-32 weeks

In our study, 17(48.6%) patients were employed having normal Doppler whereas 35(62.5%) patients were employed having abnormal Doppler. 18(51.4%) patients were unemployed having normal Doppler whereas 21(37.5%) patients were unemployed having abnormal Doppler with a p value of 0.338 which is statistically insignificant.

c) Between 32-36 weeks

In our study, 14(51.9%) patients were employed having normal Doppler whereas 21(58.3%) patients were employed having abnormal Doppler. 13(48.1%) patients were unemployed having normal Doppler whereas 15(41.7%) patients were unemployed having abnormal Doppler with a p value of 0.608 which is statistically insignificant.

FIGURE 35. DISTRIBUTION OF WOMEN UNDER STUDY ACCORDING TO OCCUPATION

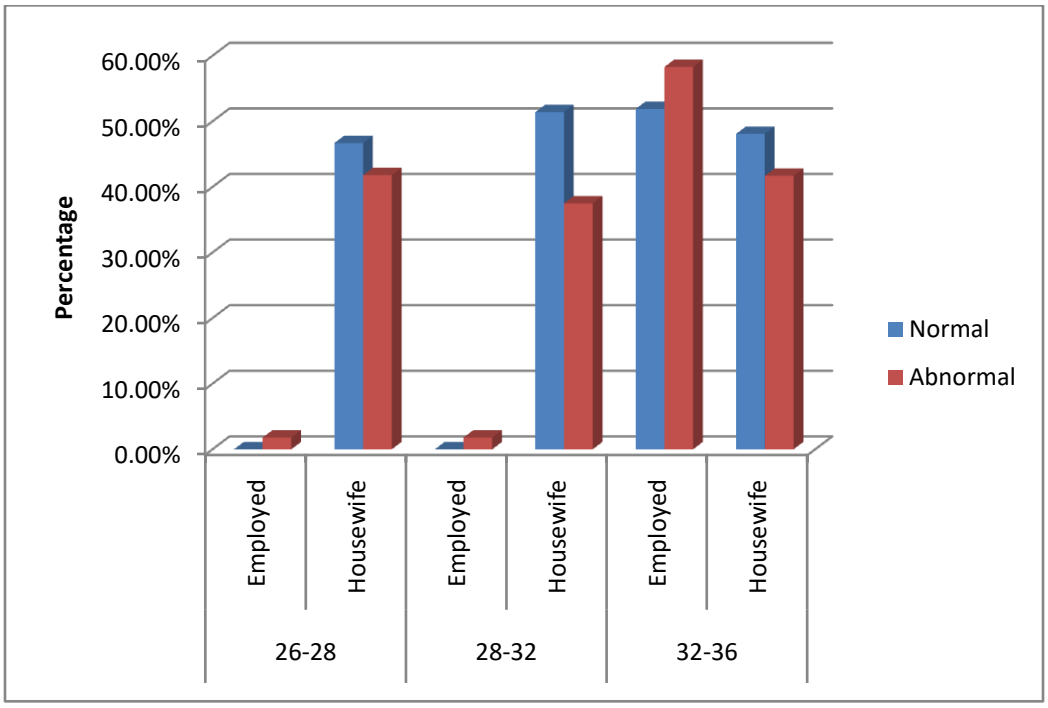


TABLE 32. DISTRIBUTION ACCORDING TO EDUCATION

		Normal		Abnormal		Total	Chi-square value	p-value
USG Doppler Evaluation done at POG(weeks)	**Education**	No. of cases	%age	No. of cases	%age			
26-28	Graduate	27	60.0%	33	60.0%	60	0.000	1.000
	Postgraduate	9	20.0%	10	18.2%	19	0.053	0.817
	Undergraduate	9	20.0%	12	21.8%	21	0.049	0.824
Total		45	100.0%	55	100.0%	100	0.082	0.960
28-32	Graduate	20	57.1%	34	60.7%	54	0.114	0.736
	Postgraduate	7	20.0%	11	19.6%	18	0.002	0.967
	Undergraduate	8	22.9%	11	19.6%	19	0.135	0.714
Total		35	100.0%	56	100.0%	91	0.154	0.926
32-36	Graduate	14	51.9%	24	66.7%	38	1.415	0.234
	Postgraduate	6	22.2%	7	19.4%	13	0.072	0.787
	Undergraduate	7	25.9%	5	13.9%	12	1.449	0.229
Total		27	100.0%	36	100.0%	63	1.793	0.408

a) Between 26-28 weeks

In our study, 27(60.0%) patients were graduate having normal Doppler while 33(60.0%) were graduate having abnormal Doppler with a p-value of 1.000 which is statistically insignificant.

9(20.0%) patients were postgraduate having normal Doppler while 10(18.2%) patients were postgraduate having abnormal doppler with a p-value of 0.817 which is statistically insignificant.

9(20.0%) patients were undergraduate having normal doppler while 12(21.8%) patients were undergraduate having abnormal doppler with a p-value of 0.824 which is statistically insignificant.

b) Between 28-32 weeks

In our study, 20(57.1%) patients were graduate having normal Doppler while 34(60.7%) were graduate having abnormal Doppler with a p-value of 0.736 which is statistically insignificant.

7(20.0%) patients were postgraduate having normal Doppler while 11(19.6%) patients were postgraduate having abnormal doppler with a p-value of 0.967 which is statistically insignificant.

8(22.9%) patients were undergraduate having normal doppler while 11(19.6%) patients were undergraduate having abnormal doppler with a p-value of 0.714 which is statistically insignificant.

c) Between 32-36 weeks

In our study, 14(51.9%) patients were graduate having normal Doppler while 24(66.7%) were graduate having abnormal Doppler with a p-value of 0.234 which is statistically insignificant.

6(22.2%) patients were postgraduate having normal Doppler while 7(19.4%) patients were postgraduate having abnormal doppler with a p-value of 0.787 which is statistically insignificant.

7(25.9%) patients were undergraduate having normal doppler while 5(13.9%) patients were undergraduate having abnormal doppler with a p-value of 0.229 which is statistically insignificant.

FIGURE 36. DISTRIBUTION ACCORDING TO EDUCATION

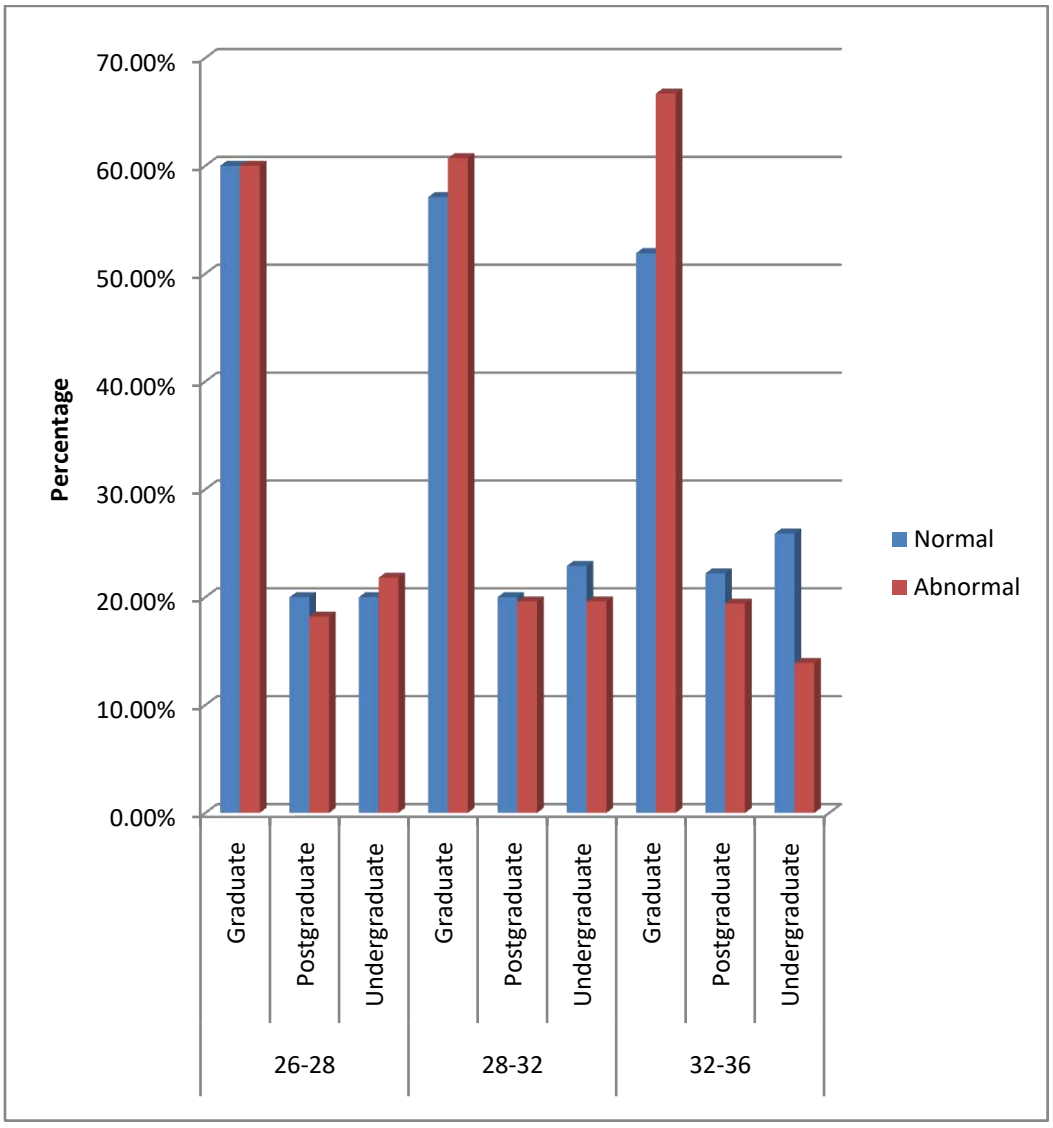


TABLE 33. COMPARISON OF WOMEN ACCORDING TO SYMPHYSIO FUNDAL HEIGHT AT 26-28 WEEKS

			Normal		Abnormal			
P/A Fundal height	Lag	2	4.4%	19	34.5%	21	14.367	0.001
	Yes	43	95.6%	36	65.5%	79		
Total		45	100.0%	55	100.0%	100		

In our study, SFH corresponded to POG in 43(95.6%) patients with normal doppler whereas 36(65.5%) patients with abnormal doppler had SFH corresponding to POG.

2(4.4%) patients with normal doppler had SFH not corresponding to POG whereas 19(34.5%) patients with abnormal doppler had SFH not corresponding to POG with a p-value of 0.001 which was statistically significant.

FIGURE 37. COMPARISON OF WOMEN ACCORDING TO SYMPHYSIO FUNDAL HEIGHT AT 26-28 WEEKS

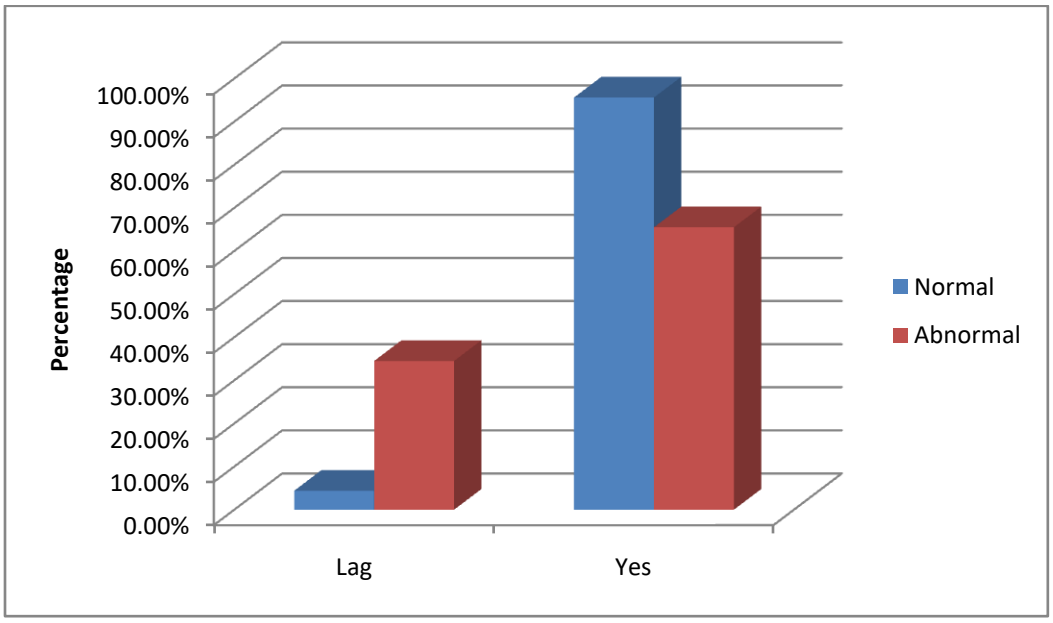


TABLE 34. COMPARISON OF WOMEN ACCORDING TO SYMPHYSIO FUNDAL HEIGHT AT 28-32 WEEKS

			Normal		Abnormal			
P/A Fundal height	Lag	1	2.9%	17	30.4%	18	10.279	0.006
	Yes	34	97.1%	39	69.6%	73		
Total		35	100.0%	56	100.0%	91		

In our study, SFH corresponded to POG in 34(97.1%) patients with normal doppler whereas 39(69.6%) patients with abnormal doppler had SFH corresponding to POG.

One (2.9%) patient with normal doppler had SFH not corresponding to POG whereas 17(30.4%) patients with abnormal doppler had SFH not corresponding to POG with a p-value of 0.006 which was statistically significant.

FIGURE 38. COMPARISON OF WOMEN ACCORDING TO SYMPHYSIO FUNDAL HEIGHT AT 28-32 WEEKS

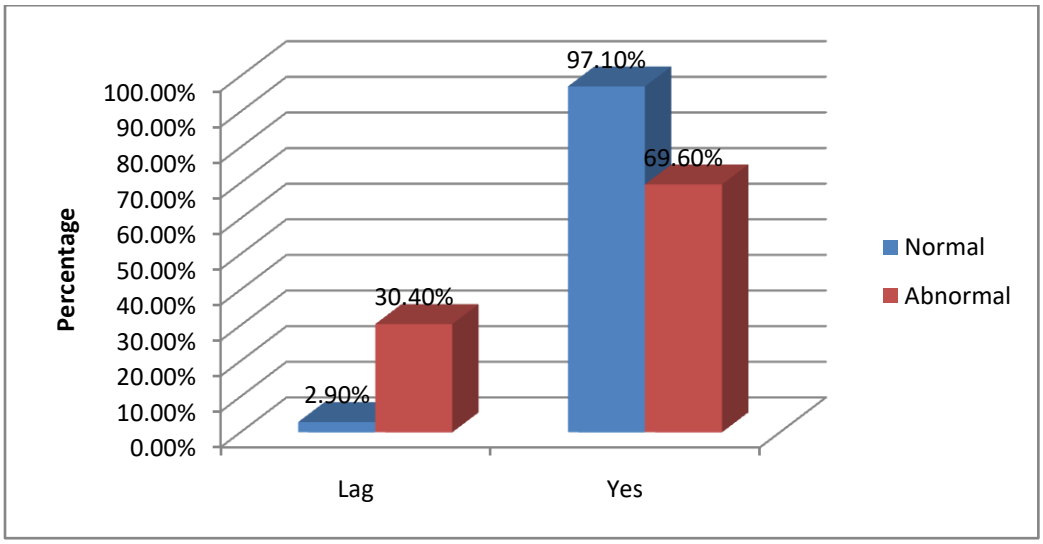


TABLE 35. COMPARISON OF WOMEN ACCORDING TO SYMPHYSIO FUNDAL HEIGHT AT 32-36 WEEKS

			Normal		Abnormal			
P/A : Fundal height	Lag	1	3.7%	8	22.2%	9	4.321	0.038
	Yes	26	96.3%	28	77.8%	54		
Total		27	100.0%	36	100.0%	63		

In our study, SFH corresponded to POG in 26(96.3%) patients with normal doppler whereas 28(77.8%) patients with abnormal doppler had SFH corresponding to POG.

One (3.7%) patient with normal doppler had SFH not corresponding to POG whereas eight (22.2%) patients with abnormal doppler had SFH not corresponding to POG with a p-value of 0.0038 which was statistically significant.

FIGURE 38. COMPARISON OF WOMEN ACCODING TO SYMPHYSIO FUNDAL HEIGHT AT 32-36 WEEKS

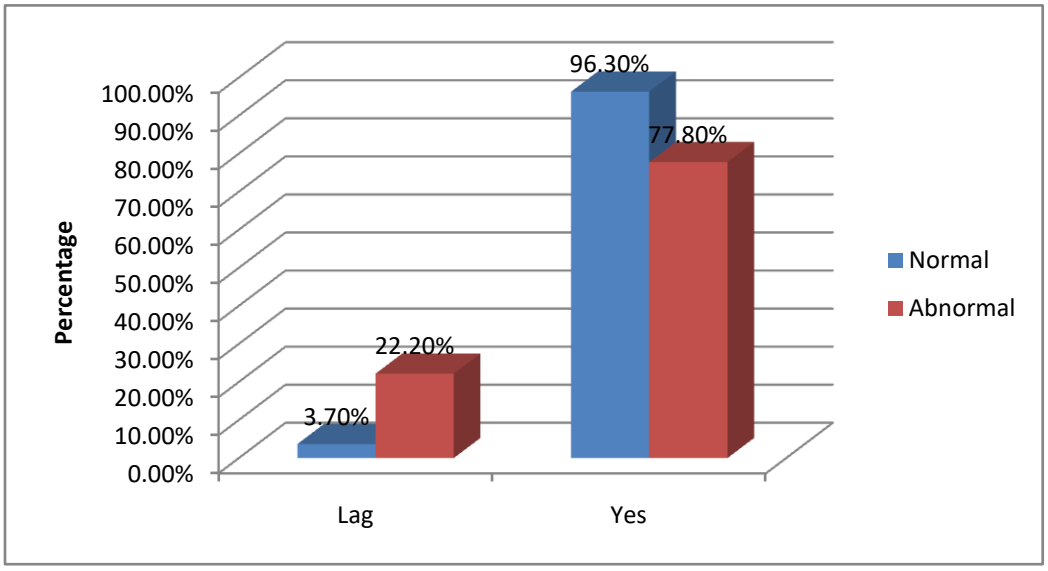


TABLE 36. DISTRIBUTION ACCORDING TO PREGNANCY COMPLICATIONS

Period of gestation at time of delivery	**Risk factors**	Normal		Abnormal		Total	Chi-square value	p-value
		Normal	Normal	Abnormal	Abnormal			
26-28	No	30	68.9%	21	41.8%	51	8.719	0.033
	HTN	14	31.1%	32	58.2%	46		
	SUA	0	0.0%	1	0.0%	1		
	Maternal thyroid	1	0.0%	1	0.0%	2		
28-32	No	26	74.3%	21	48.2%	47	12.217	0.016
	HTN	9	25.7%	29	51.8%	38		
	SLE	0	0.0%	2	0.0%	2		
	CMV IgM+	0	0.0%	1	0.0%	1		
	Maternal heart disease	0	0.0%	2	0.0%	2		
	Maternal anemia	0	0.0%	1	0.0%	1		
32-36	No	18	81.5%	7	52.8%	25	15.062	0.005
	HTN	7	25.9%	23	63.9%	30		
	DM	2	7.4%	4	11.1%	6		
	CMV IgM+	0	0.0%	1	2.8%	0		
	IDIOPATIC	0	0.0%	1	0.0%	0		
Total		27	100.0%	36	100.0%	63		

In our study, between 26-28 weeks hypertension was present in 14(31.1%) vs 32(58.2%) in patients with normal and abnormal doppler respectively with a p-value of 0.033 which is statistically significant. SUA was present in 1(0.0%) patient with abnormal Doppler. 1(0.0%) vs 1(0.0%) patients had maternal thyroid disease in patients with normal and abnormal doppler respectively.

Between 28-32 weeks, hypertension was present in 9(25.7%) vs 29(51.8%) patients of normal and abnormal Doppler respectively with a p-value of 0.016 which is statistically insignificant. 2(0.0%) patients had SLE in patients having abnormal Doppler. CMV-Ig M was positive in 1(0.0%) patient having abnormal Doppler. 2(0.0%) patients had heart disease and abnormal antenatal Doppler. 1(0.0%) patient had anemia with abnormal antenatal Doppler.

Between 32-36 weeks, hypertension was present in 7(25.9%) vs 23(63.9%) patients having normal and abnormal doppler respectively with a p-value of 0.005 which is statistically significant. 2(7.4%) vs 4(11.1%) patients were diabetic having normal and abnormal Doppler respectively. CMV-Ig M was positive in 1(2.8%) patient having abnormal Doppler. 1(0.0%) patient had abnormal Doppler which was idiopathic.

FIGURE 40. DISTRIBUTION ACCORDING TO PREGNANCY COMPLICATIONS

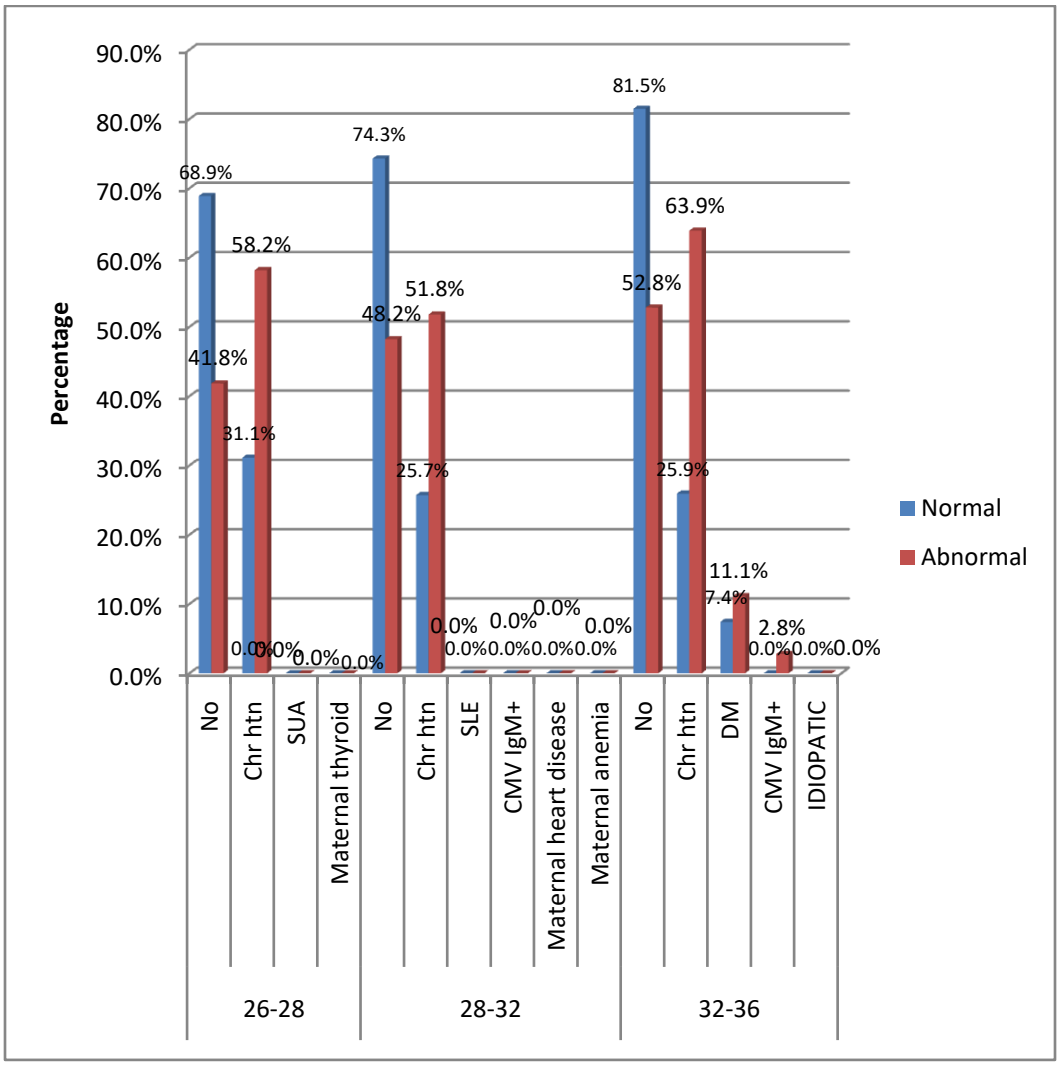


TABLE 37. DISTRIBUTION ACCORDING TO MODE OF DELIVERY

Period of gestation at the time of delivery gp			Normal		Abnormal		Total	Chi-square value	p-value
			No. of cases	%age	No. of cases	%age			
< 28	Mode of delivery	Cesarean		0.0%	8	88.9%	8		
		Vaginal		0.0%	1	11.1%	1		
	Total			0.0%	9	100.0%	9		
28-32	Mode of delivery	Cesarean	2	40.0%	15	65.2%	17	1.095	0.295
		Vaginal	3	60.0%	8	34.8%	11		
	Total		5	100.0%	23	100.0%	28		
32-36	Mode of delivery	Cesarean	8	57.1%	13	81.3%	21	2.066	0.151
		Vaginal	6	42.9%	3	18.8%	9		
	Total		14	100.0%	16	100.0%	30		
> 37	Mode of delivery	Cesarean	3	23.1%	10	50.0%	13	2.392	0.122
		Vaginal	10	76.9%	10	50.0%	20		
	Total		13	100.0%	20	100.0%	33		

In our study, 9 babies delivered <28 weeks out of which 8(88.9%) and 1(11.1%) underwent cesarean and vaginal delivery respectively in patients with abnormal Doppler.

28 babies delivered between 28-32 weeks out of which 2(40.0%) vs 15(65.2%) underwent cesarean delivery in patients with normal and abnormal Doppler respectively compared to 3(60.0%) vs 8(34.8%) underwent vaginal delivery in patients with normal and abnormal Dopper respectively with a p-value of 0.295 which is statistically insignificant.

30 babies delivered between 32-36 weeks out of which 8(57.1%) vs 13(81.3%) underwent cesarean in patients with normal and abnormal Doppler respectively compared to 6(42.9%) vs 3(18.8%) delivered vaginally in patients with normal and abnormal Doppler respectively with a p-value of 0.151 which is statistically insignificant.

33 babies delivered >37 weeks out of which 3(23.1%) vs 10(50.0%) underwent cesarean delivery in patients with normal and abnormal Doppler respectively compared to 10(76.9%) vs 10(50.0%) babies delivered vaginally in patients with normal and abnormal Doppler respectively with a p-value of 0.122 which is statistically insignificant.

FIGURE 41. DISTRIBUTION ACCORDING TO MODE OF DELIVERY

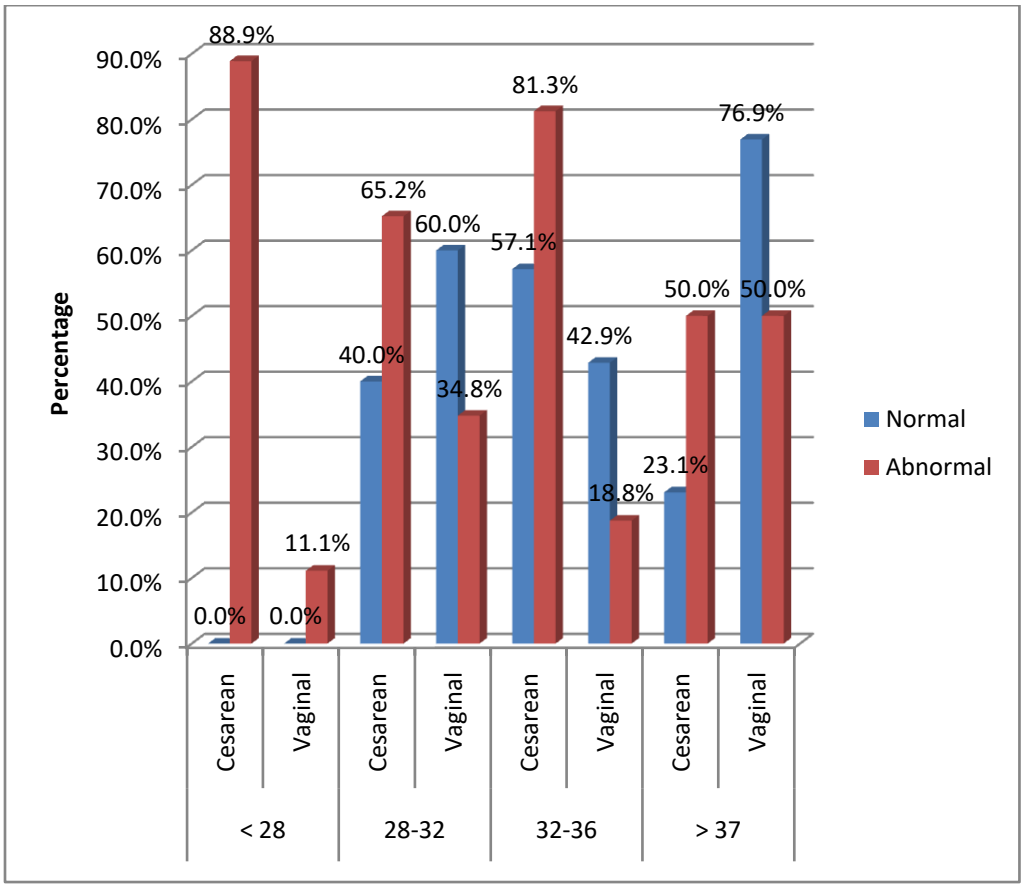


TABLE 38. DISTRIBUTION ACCORDING TO NICU ADMISSIONS

Period of gestation at the time of delivery gp			Normal		Abnormal		Total	Chi-square value	p-value
			No. of cases	%age	No. of cases	%age			
< 28	Admisssion to NICU	Yes		0.0%	9	100.0%	9		
	Total			0.0%	**9**	100.0%	9		
28-32	Admisssion to NICU	No	1	20.0%	1	4.3%	2	1.517	0.218
		Yes	4	80.0%	22	95.7%	26		
	Total		5	100.0%	23	100.0%	28		
32-36	Admisssion to NICU	No	11	78.6%	5	31.3%	16	6.718	0.014
		Yes	3	21.4%	11	68.8%	14		
	Total		14	100.0%	16	100.0%	30		
> 37	Admisssion to NICU	No	12	92.3%	12	60.0%	24	4.146	0.042
		Yes	1	7.7%	8	40.0%	9		
	Total		13	100.0%	20	100.0%	33		

In our study, 9 babies who delivered <28 weeks all 9(9%) were admitted to NICU in mothers with abnormal doppler.

28 Babies delivered between 28-32 weeks out of which 4(80.0%) vs 22(95.7%) were admitted in NICU in mothers with normal and abnormal doppler respectively with a p-value of 0.218 which is statistically insignificant.

30 babies delivered between 32-36 weeks out of which 3(21.4%) vs 11(68.8%) babies were admitted to NICU in mothers with normal and abnormal doppler respectively with a p-value of 0.014 which is statistically significant.

33 babies were delivered >37 weeks out of which 1(7.7%) vs 8(40.0%) babies were admitted to NICU in mothers with normal and abnormal doppler respectively with a p-value of 0.042 which is statistically significant.

FIGURE 42: DISTRIBUTION ACCORDING TO NICU ADMISSIONS

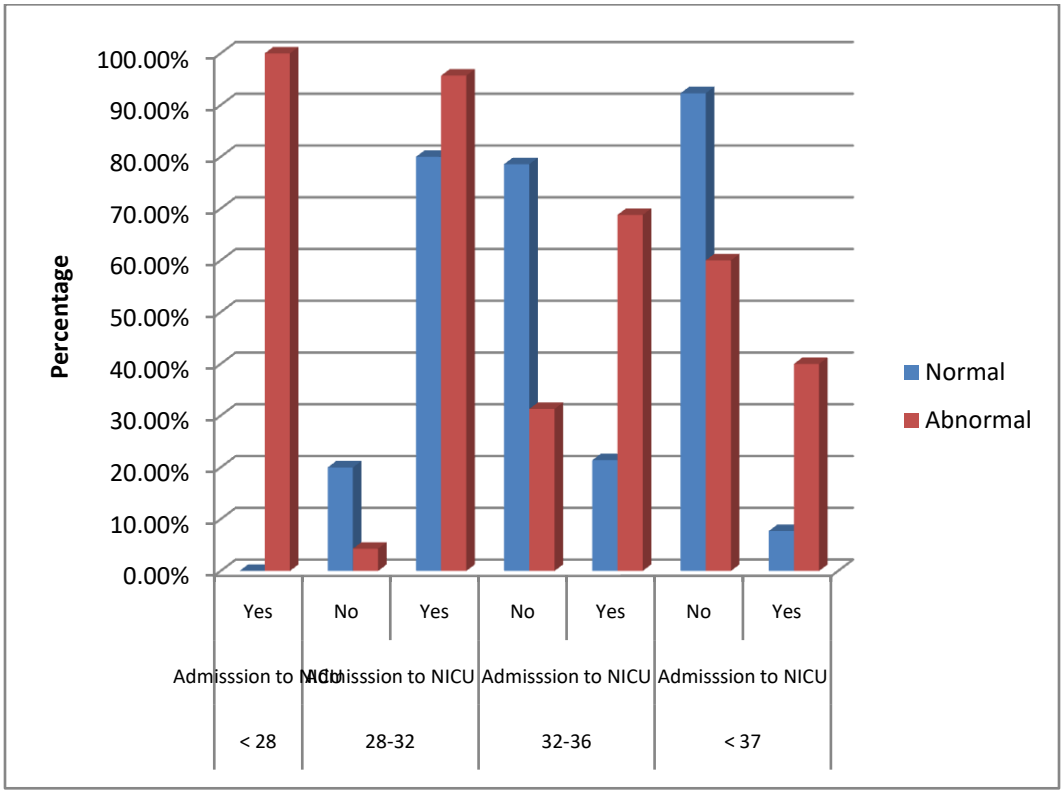


TABLE 39: DISTRIBUTION ACCORDING TO BIRTH WEIGHT

Period of gestation at the time of delivery gp		Normal		Abnormal		Total	Chi-square value	p-value	
			No. of cases	%age	No. of cases	%age			
<28		AGA			3	33.3%	3		
		SGA			6	66.7%	6		
	Total				9	100.0%	9		
28-32		AGA	4	80.0%	4	17.4%	8	7.889	0.005
		SGA	1	20.0%	19	82.6%	20		
	Total		5	100.0%	23	100.0%	28		
32-36		AGA	11	78.6%	4	25.0%	15	8.571	0.003
		SGA	3	21.4%	12	75.0%	15		
	Total		14	100.0%	16	100.0%	30		
> 37		AGA	6	46.2%	5	25.0%	11	1.587	0.208
		SGA	7	53.8%	15	75.0%	22		
	Total		13	100.0%	20	100.0%	33		

In our study, 9 babies delivered <28 weeks all having abnormal Doppler out of which 3(33.3%) vs 6(66.7%) babies were small for gestational age in patients with abnormal Doppler.

28 babies delivered between 28-32 weeks out of which 4(80.0%) vs 4(17.4%) babies were appropriate for gestational age in patients with normal and abnormal Doppler respectively compared with 1(20.0%) vs 19(82.6%) babies were small for gestational age in patients with normal and abnormal Doppler respectively with a p-value of 0.005 which is statistically significant.

30 babies delivered between 32-36 weeks out of which 11(78.6%) vs 4(25.0%) babies were appropriate for gestational age in patients with normal and abnormal Doppler respectively compared with 3(21.4%) vs 12(75.0%) babies were small for gestational age in patients with normal and abnormal Doppler respectively with a p-value of 0.003 which is statistically significant.

33 babies delivered >37 weeks out of which 6(46.2%) vs 5(25.0%) babies were appropriate for gestational age in patients with normal and abnormal Doppler respectively compared with 7(53.8%) vs 15(75.0%) babies were small for gestational age in patients with normal and abnormal Doppler respectively with a p-value of 0.208 which is statistically insignificant.

FIGURE 43. DISTRIBUTION ACCORDING TO BIRTH WEIGHT

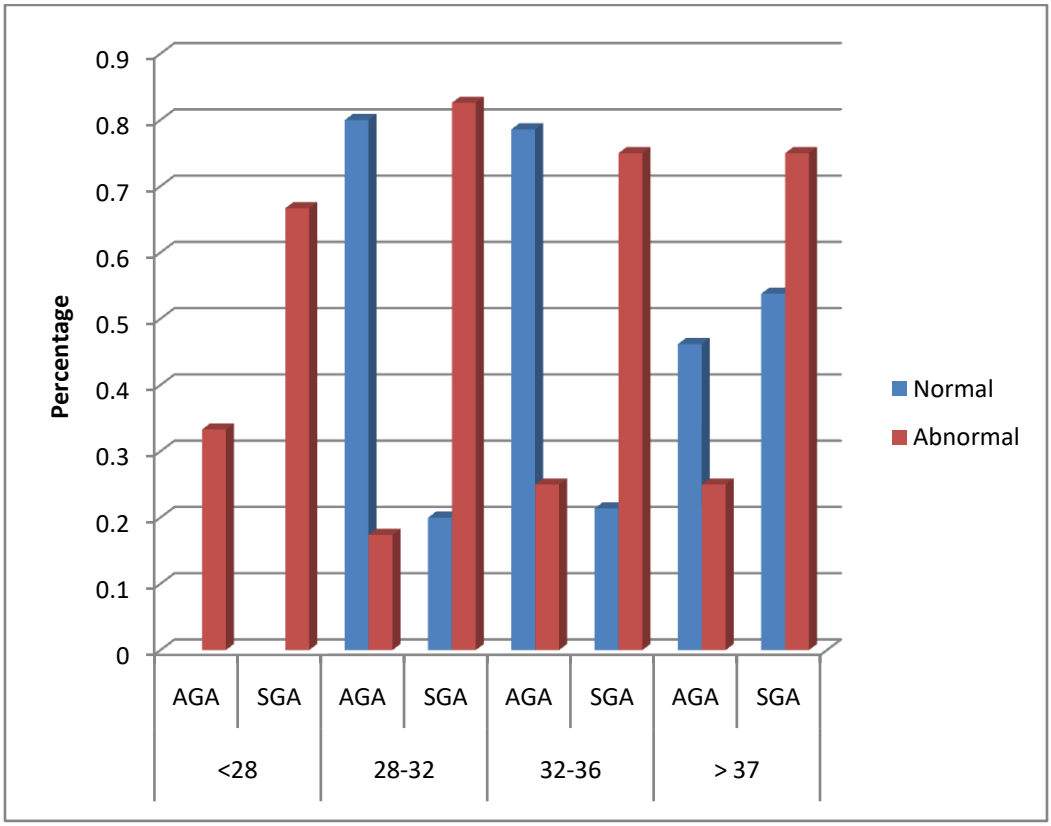


TABLE 40. COMPARISON ACCORDING TO UT-A PI, UA-S/D, MCA-PI AND BIRTH WEIGHT

		UT A PI			Total	Chi-square value		p-value
		Normal		Abnormal				
BIRTH WEIGHT	AGA	29	44.6%	8	22.9%	37	4.62	0.032
	SGA	36	55.4%	27	77.1%	63		
Total		65	100.0%	35	100.0%	100		

		UA S/D			Total	Chi-square value	p-value	
		Normal		Abnormal				
BIRTH WEIGHT	AGA	23	56.1%	14	23.7%	37	10.873	0.001
	SGA	18	43.9%	45	76.3%	63		
Total		41	100.0%	59	100.0%	100		

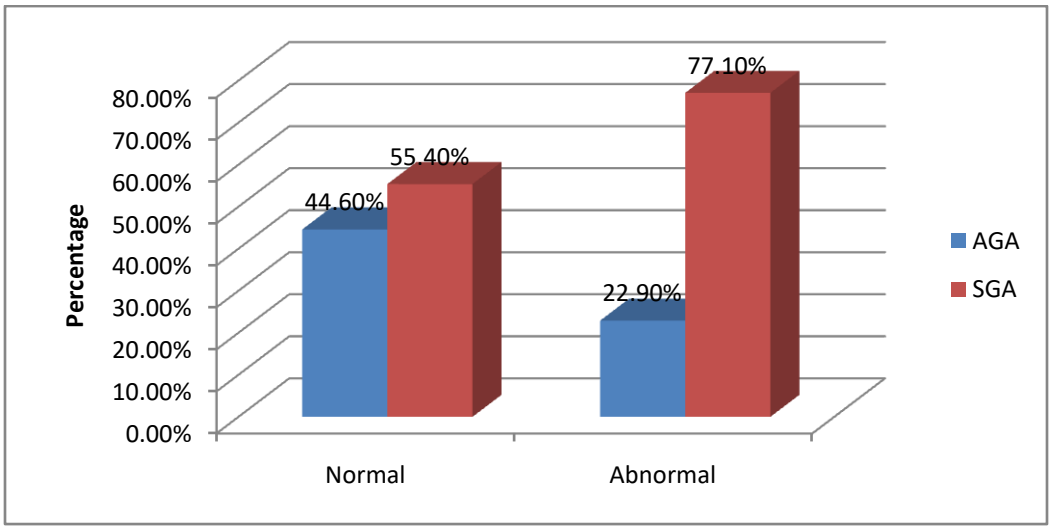
		MCA PI			Total	Chi-square value	p-value	
		Normal		Abnormal				
BIRTH WEIGHT	AGA	23	45.1%	14	28.6%	37	2.928	0.087
	SGA	28	54.9%	35	71.4%	63		
Total		51	100.0%	49	100.0%	100		

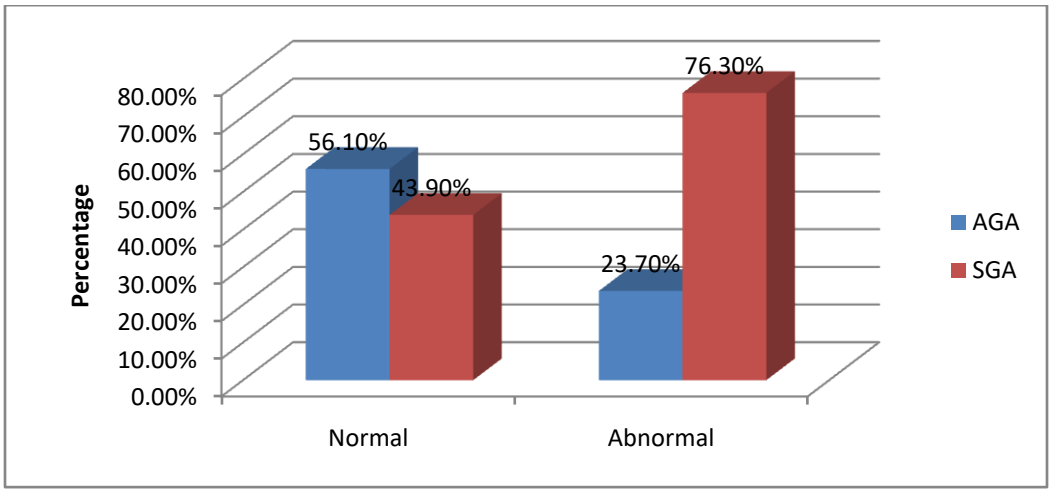
In our study, 29(44.6%) vs 8(22.9%) babies were appropriate for gestational age in patients with normal and abnormal uterine artery PI respectively compared with 36(55.4%) vs 27(77.1%) babies were small for gestational age in patients with normal and abnormal uterine artery PI respectively with a p-value of 0.032 which is statistically significant.

In our study, 23(56.1%) vs 14(23.7%) babies were appropriate for gestational age in patients with normal and abnormal umbilical artery S/D respectively compared with 18(43.9%) vs 45(76.3%) babies were small for gestational age in patients with normal and abnormal umbilical artery S/D respectively with a p-value of 0.001 which is statistically significant.

In our study, 23(45.1%) vs 14(28.6%) babies were appropriate for gestational age in patients with normal and abnormal MCA-PI respectively compared with 28(54.9%) vs 35(71.4%) babies were small for gestational age in patients with normal and abnormal MCA-PI respectively with a p-value of 0.087 which is statistically insignificant.

FIGURE 44: COMPARISON ACCORDING TO UT-A PI,UA-S/D,MCA-PI AND BIRTH WEIGHT





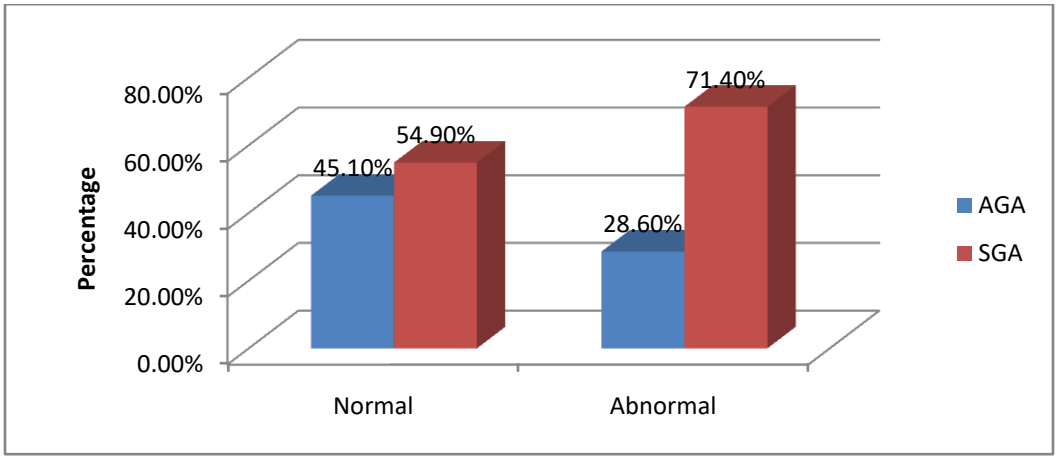


TABLE 41. COMPARISON ACCORDING TO BIRTH WEIGHT AND ULTRASOUND DOPPLER

			Normal			Abnormal		Total	Chi-square value	p-value
			No. of cases	%age		No. of cases	%age			
BIRTH WEIGHT	AGA	NORMAL	21	65.6%	FALSE POSITIVE	16	23.5%	37	16.542	0.001
	SGA	FALSE NEGATIVE	11	34.4%	FGR	52	76.5%	63		
Total			32	100.0%		68	100.0%	100		

In our study, 21(65.6%) vs 16(23.5%) babies were appropriate for gestational age in patients with normal and abnormal Doppler respectively.

11(34.4%) vs 52(76.5%) babies were small for gestational age in patients with normal and abnormal Doppler respectively.

FIGURE 45. COMPARISON BETWEEN BIRTH WEIGHT AND ULTRASOUND DOPPLER

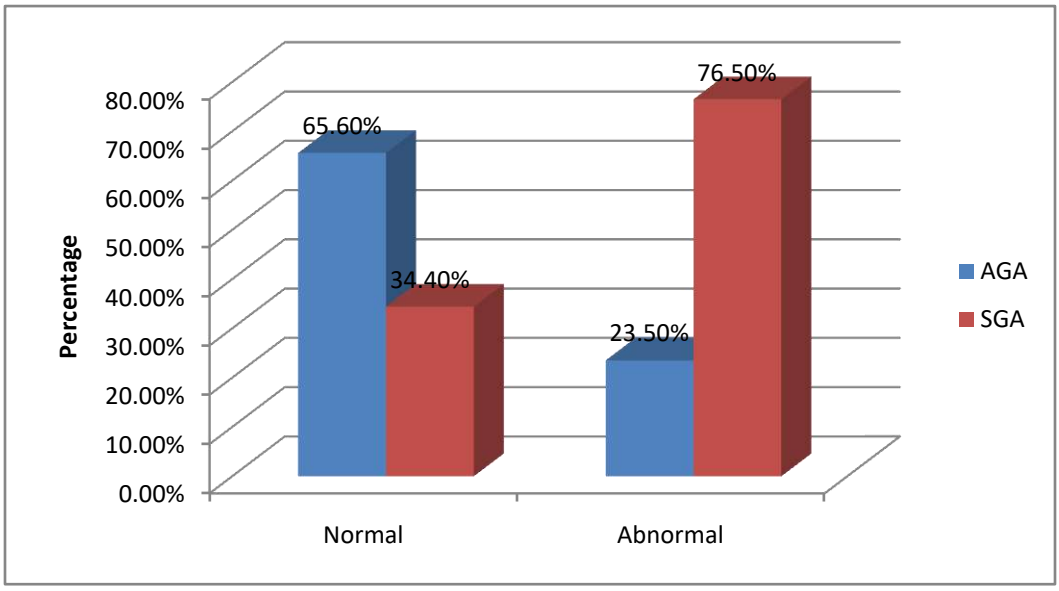


TABLE 42. COMPARISON ACCORDING TO BIRTH WEIGHT, ULTRASOUND DOPPLER AND ADMISSION TO NICU

										Total	Chi-square value	p-value
		Normal		False Negative		False Positive		FGR				
Admisssion to NICU GP	N	17	81.0%	7	63.6%	8	50.0%	10	19.2%	42	26.681	0.001
	Y	4	19.0%	4	36.4%	8	50.0%	42	80.8%	58		
Total		21	100.0%	11	100.0%	16	100.0%	52	100.0%	100		

In our study, 17(81.0%) vs 7(63.6%) babies had normal Doppler and appropriate for gestational age vs those with normal Doppler and small for gestational age respectively were not admitted to NICU. 8(50.0%) vs 10(19.2%) babies with abnormal Doppler and appropriate for gestational age vs those with abnormal Doppler and were small for gestational age i.e had FGR respectively were not admitted to NICU.

4(19.0%) vs 4(36.4%) babies had normal Doppler and appropriate for gestational age vs those with normal Doppler and small for gestational age respectively were admitted to NICU. 8(50.0%) vs 42(80.8%) babies with abnormal Doppler and appropriate for gestational age vs those with abnormal Doppler and were small for gestational age i.e had FGR respectively were admitted to NICU with a p-value of 0.001 which is statistically significant.

FIGURE 46. COMPARISON ACCORDING TO BIRTH WEIGHT, ULTRASOUND DOPPLER AND ADMISSION TO NICU.

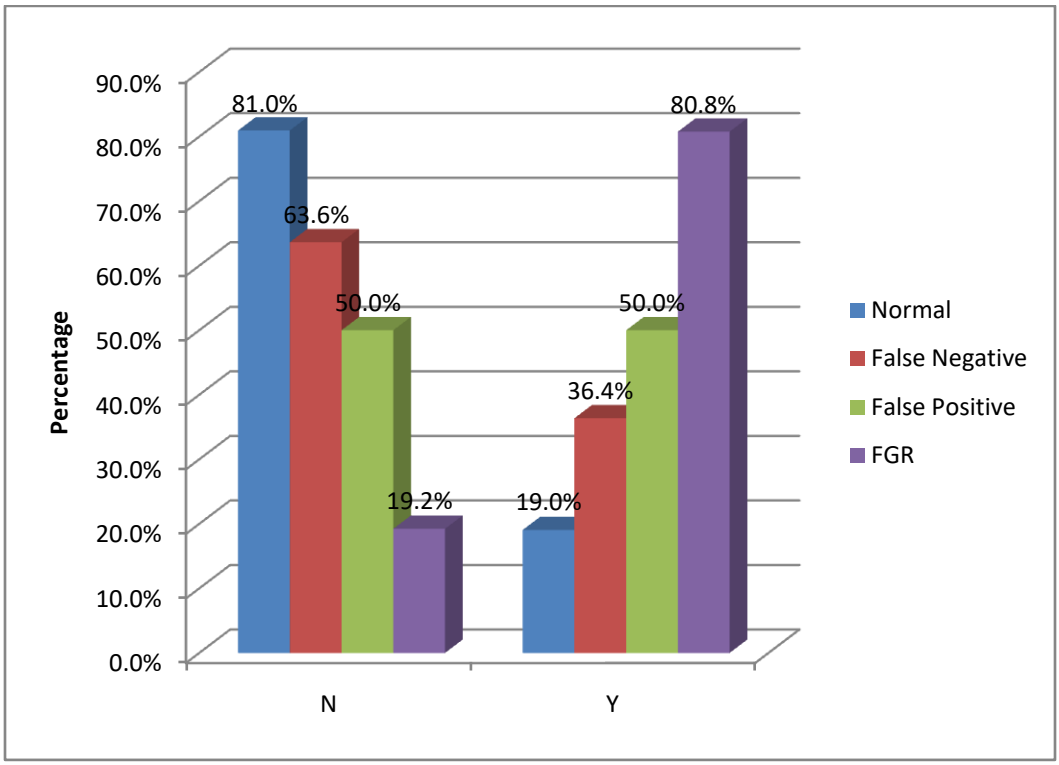


TABLE 43. COMPARISON ACCORDING TO BIRTH WEIGHT, ULTRASOUND DOPPLER AND INDICATION OF ADMISSION TO NICU

Admisssion to NICU GP										Total	Chi-square value	p-value
		Normal		False Negative		False Positive		FGR				
Prematurity	No	1	25.0%	1	25.0%	1	12.5%	7	16.7%	10	0.473	0.925
	Prematurity	3	75.0%	3	75.0%	7	87.5%	35	83.3%	48		
Total		4	100.0%	4	100.0%	8	100.0%	42	100.0%	58		
ABN Doppler	ABN Doppler	0	0.0%	0	0.0%	4	50.0%	35	83.3%	39	22.438	0.001
	No	4	100.0%	4	100.0%	4	50.0%	7	16.7%	19		
Total		4	100.0%	4	100.0%	8	100.0%	42	100.0%	58		
Increased rates of breathing	No	4	100.0%	4	100.0%	7	87.5%	39	92.9%	54	0.988	0.804
	Present	0	0.0%	0	0.0%	1	12.5%	3	7.1%	4		
Total		4	100.0%	4	100.0%	8	100.0%	42	100.0%	58		

In our study, 3(75.0%) vs 3(75.0%) babies were admitted to NICU in patients having normal Doppler and appropriate for gestational age vs normal Doppler and small for gestational age respectively were admitted to NICU i/v/o prematurity. 7(87.5%) vs 35 (83.3%) babies were admitted to NICU i/v/o prematurity in patients having abnormal Doppler and appropriate for gestational age vs abnormal Doppler and small for gestational age respectively with a p-value of 0.925 which is statistically insignificant.

0(0.0%) vs 0(0.0%) babies were admitted to NICU in patients having normal Doppler and appropriate for gestational age vs normal Doppler and small for gestational age respectively were admitted to NICU i/v/o abnormal doppler. 4(50.0%) vs 35 (83.3%) babies were admitted to NICU

i/v/o abnormal doppler in patients having abnormal Doppler and appropriate for gestational age vs abnormal Doppler and small for gestational age respectively with a p-value of 0.001 which is statistically significant.

0(0.0%) vs 0(0.0%) babies were admitted to NICU in patients having normal Doppler and appropriate for gestational age vs normal Doppler and small for gestational age respectively were admitted to NICU i/v/o increased rates of breathing. 1(12.5%) vs 3(7.1%) babies were admitted to NICU i/v/o increased rates of breathing in patients having abnormal Doppler and appropriate for gestational age vs abnormal Doppler and small for gestational age respectively with a p-value of 0.804 which is statistically insignificant.

FIGURE 47. COMPARISON ACCORDING TO BIRTH WEIGHT, ULTRASOUND DOPPLER AND INDICATION OF ADMISSION TO NICU

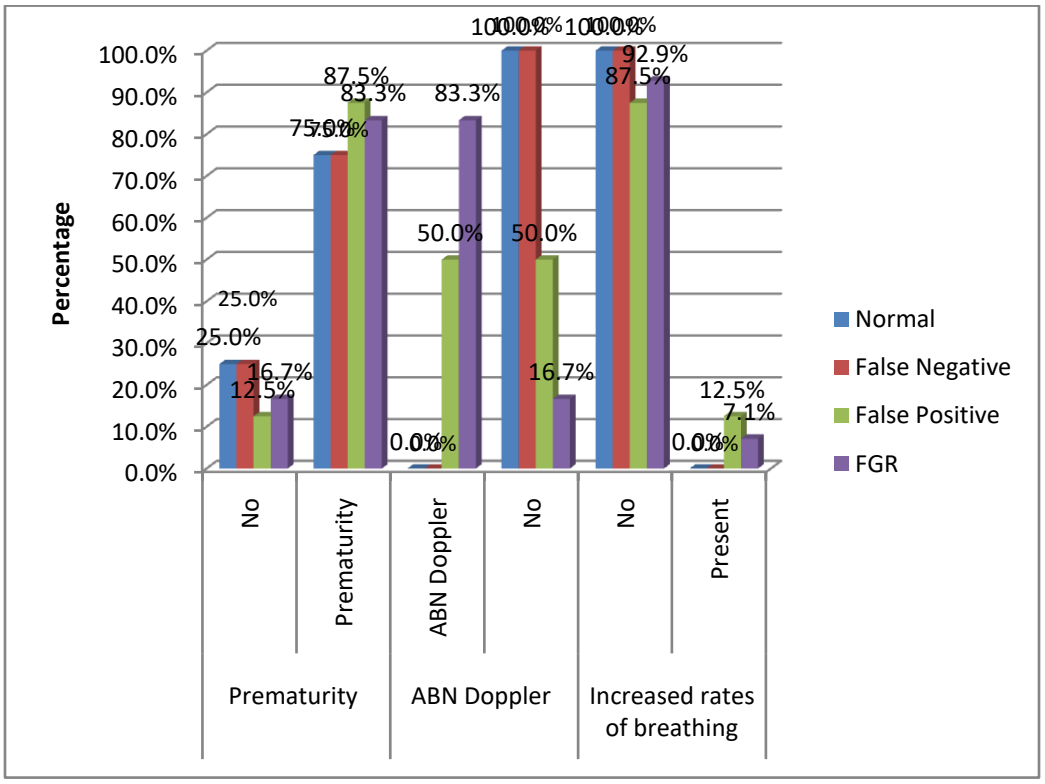


TABLE 44. COMPARISON ACCORDING TO BIRTH WEIGHT, ULTRASOUND DOPPLER AND PERINATAL COMPLICATIONS.

Perinatal complications										Total	Chi-square value	p-value
		Normal		False Negative		False Positive		FGR				
RDS	N	21	100.0%	8	72.7%	12	75.0%	26	50.0%	67	17.767	0.001
	Y	0	0.0%	3	27.3%	4	25.0%	26	50.0%	33		
NEONATAL HYPERBILIRUBINEMIA	N	21	100.0%	9	81.8%	16	100.0%	38	73.1%	84	11.703	0.008
	Y	0	0.0%	2	18.2%	0	0.0%	14	26.9%	16		
NEC	N	21	100.0%	11	100.0%	13	81.3%	41	78.8%	86	7.719	0.052
	Y	0	0.0%	0	0.0%	3	18.8%	11	21.2%	14		

In our study, 0(0.0%) vs 3(27.3%) babies developed RDS in patients with normal Doppler and AGA babies vs those with normal Doppler and SGA babies respectively compared to 4(25.0%) vs 26(50.0%) babies who developed RDS in patients with abnormal Doppler and AGA babies vs those with abnormal Doppler and SGA babies respectively with a p-value of 0.001 which is statistically significant.

0(0.0%) vs 2(18.2%) babies developed hyperbilirubinemia in patients with normal Doppler and AGA babies vs those with normal Doppler and SGA babies respectively compared to 0(0.0%) vs 14(26.9%) babies who developed hyperbilirubinemia in patients with abnormal Doppler and AGA babies vs those with abnormal Doppler and SGA babies respectively with a p-value of 0.008 which is statistically significant.

0(0.0%) vs 0(0.0%) babies developed NEC in patients with normal Doppler and AGA babies vs those with normal Doppler and SGA babies respectively compared to 3(18.8%) vs 11(21.2%) babies who developed NEC in patients with abnormal Doppler and AGA babies vs those with abnormal Doppler and SGA babies respectively with a p-value of 0.052 which is statistically insignificant.

FIGURE 48. COMPARISON ACCORDING TO BIRTH WEIGHT, ULTRASOUND DOPPLER AND PERINATAL COMPLICATIONS.

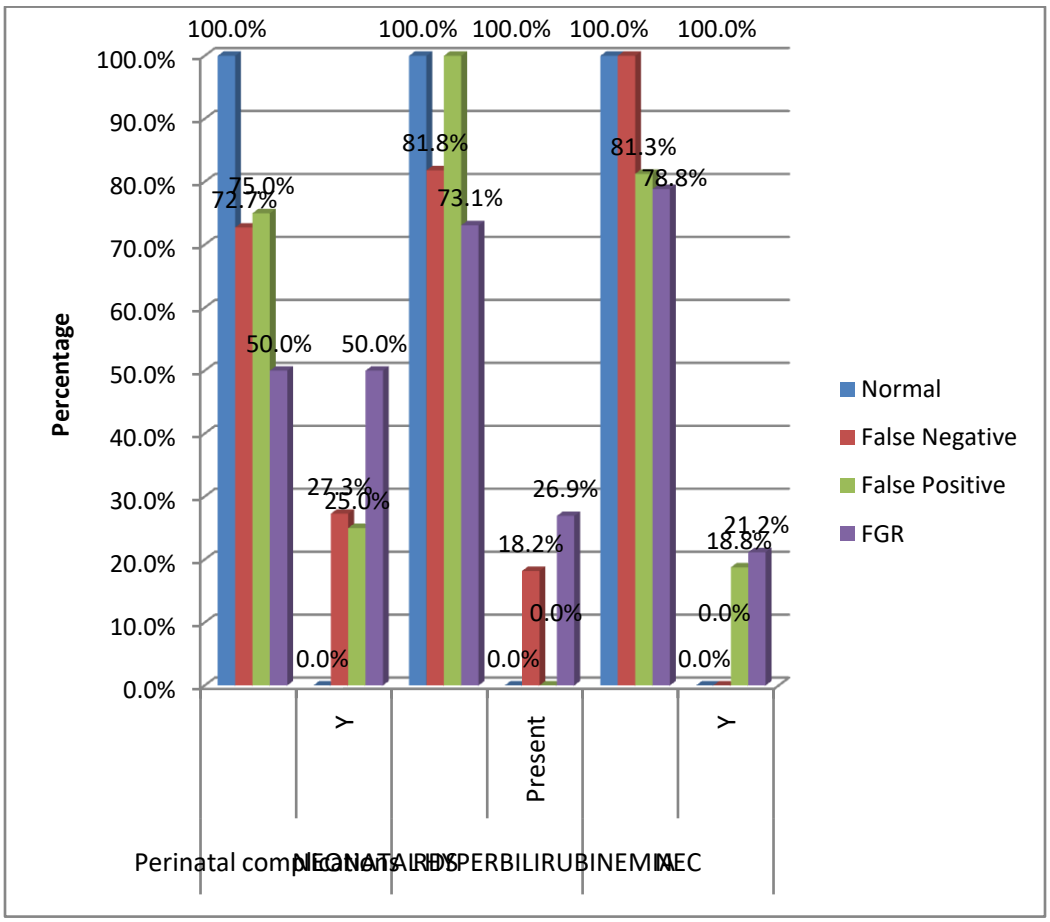


TABLE 45. COMPARISON ACCORDING TO BIRTH WEIGHT, ULTRASOUND DOPPLER AND NEONATAL DEATHS

										Total	Chi-square value	p-value
		Normal		False Negative		False Positive		FGR				
Neonatal death	N	21	100.0%	11	100.0%	14	87.5%	46	88.5%	92	4.107	0.250
	Y	0	0.0%	0	0.0%	2	12.5%	6	11.5%	8		
Total		21	100.0%	11	100.0%	16	100.0%	52	100.0%	100		

In our study, 2(12.5%) vs 6(11.5%) neonates died in patients with abnormal Doppler and birth weight >10th centile compared to those with abnormal Doppler and birth weight <10th centile respectively with a p-value of 0.250 which is statistically insignificant.

FIGURE 49. COMPARISON ACCORDING TO BIRTH WEIGHT, ULTRASOUND DOPPLER AND NEONATAL DEATHS.

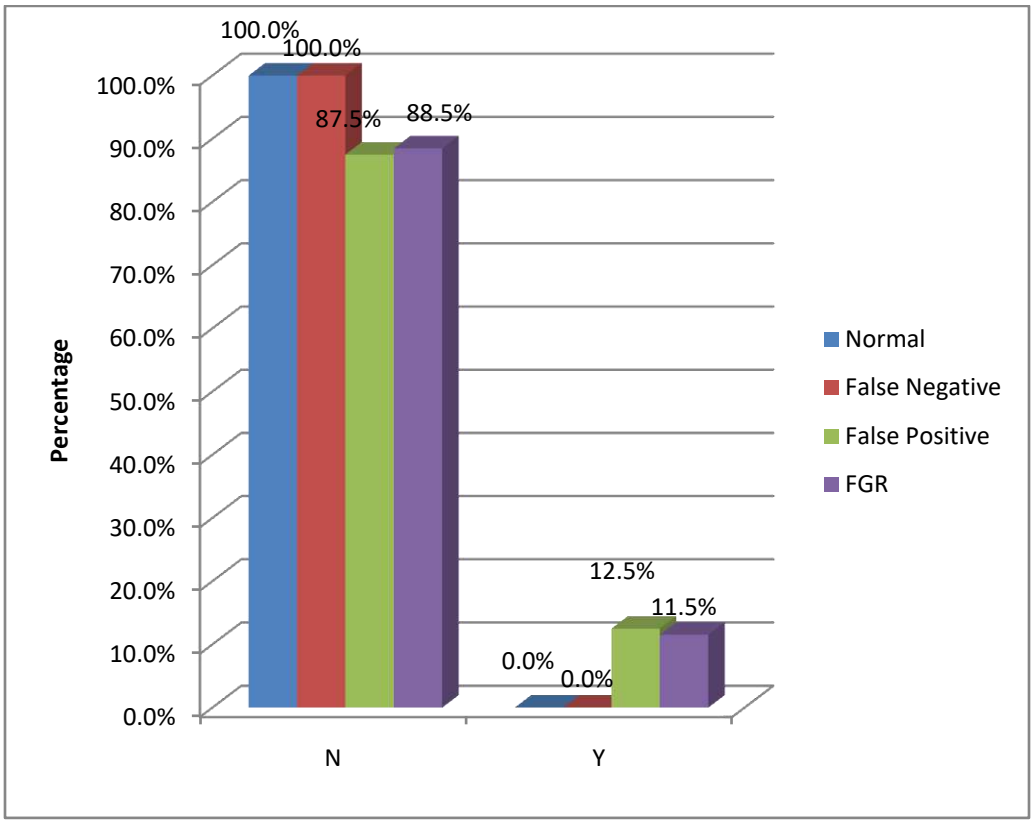
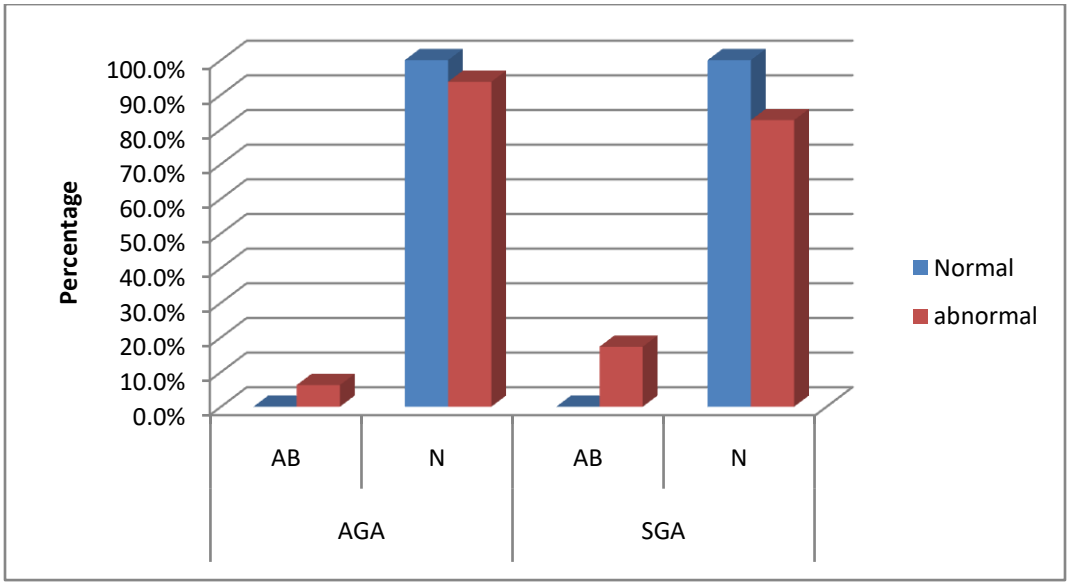


TABLE 46. DISTRIBUTION ACCORDING TO CEREBROPLACENTAL RATIO IN AGA AND SGA BABIES

BIRTH WEIGHT			Normal		abnormal		Total	Chi-square value	p-value
			No. of cases	%age	No. of cases	%age			
AGA	CPR	AB	0	0.0%	1	6.3%	1	1.349	0.245
		N	21	100.0%	15	93.8%	36		
	Total		21	100.0%	16	100.0%	37		
SGA	CPR	AB	0	0.0%	9	17.3%	9	2.221	0.136
		N	11	100.0%	43	82.7%	54		
	Total		11	100.0%	52	100.0%	63		

Total 10 babies had abnormal cerebroplacental ratio out of which 1(6.3%) baby had birth weight >10th centile and 9(17.3%) babies had abnormal CPR and birth weight <10th centile for gestational age with a statistically insignificant p-value.



DISCUSSION

This is a prospective study conducted in the Department of Obstetrics and Gynaecology, and Radiodiagnosis at DMC&H, Ludhiana. A total of 100 antenatal patients were recruited who attended antenatal clinic or were admitted in antenatal ward at DMCH, Ludhiana and were subjected to USG fetal well-being and Doppler at 26-28 weeks, 28-32 weeks and 32-36 weeks gestation for assessment of fetal well-being and diagnosis of FGR.

FGR increases the perinatal mortality and morbidity. The early prediction of FGR infants decreases adverse perinatal outcomes.

DEMOGRAPHIC PARAMETERS

AGE

In our study out of 100 patients, 23 (23%) patients were of age group <25 years while 48 (48%) patients were of age group 26-30 years and 29 (29%) patients were of age group >30 years. The minimum age was 22 years while maximum age was 55 years. Majority of patients belonged to 26-30 years age group.

FGR in younger mothers is explained by the fact that they are less likely to seek antenatal care and appropriate nutrition and are more likely to be primiparous. Similar results were documented by Caroline HD Fall et al which determined that young maternal age was associated with an increased risk of fetal growth restriction and small for gestational age babies [86]. Our observation is different from that of Naoko Kazuki et al who had concluded that advanced maternal age is associated with higher perinatal mortality and an increased risk of fetal growth restriction and low birth weight [87]. Older women are at a higher risk of gestational diabetes and preeclampsia which impairs fetal development [88]. These comorbidities lead to placental insufficiency and FGR.

PARITY

In our study out of 100 patients, 64 (64.0%) were primiparous and 36(36.0%) were multiparous. The results were similar to Wendy Moh et al who reported that primiparity was associated with FGR [89]. This is supported by another study done in 2014 by Albu AR et al who observed that nulliparous women have an increased risk of FGR [90]. Multiparous women are more likely to have awareness of their nutritional needs and took standard antenatal treatment.

EDUCATION AND OCCUPATION

In our study of 100 patients majority of the patients were graduate, 61.0 % (n=100) with 21.0% (n=100) being undergraduate and 19.0% (n=44) being post graduate. Also, out of 100 patients (n=100) 56.0% patients were employed whereas 44.0% patients were unemployed. This result supports the observations by Saleem T et al and they observed that there is a strong link between higher maternal educations with an improved birth outcome [91]. Sebestian et al observed that illiterate and unskilled workers had a lack of awareness of good nutrition [92]. Their financial status included adequate antenatal care, nutrition and support from family as well.

CLINICAL PARAMETERS- SYMPHYSIO-FUNDAL HEIGHT

In our study out of 100 patients, 78(78%) patients had SFH corresponding to period of gestation and 22(22%) patients had SFH not corresponding to period of gestation. A comparison of women was done according to symphysio fundal height measurement at 26-28 weeks, 28-32 weeks and 32-36 between patients with normal and abnormal Doppler with a p-value of 0.001, 0.006 and 0.003 respectively suggesting a lag was present in SFH in patients with abnormal Doppler. These results were supported by the study done by Aase Serine D Pay et al who observed that the sensitivity of SFH measurement for SGA (BW < 10th percentile) prediction

ranged from 0.27 to 0.76 and specificity ranged from 0.79 to 0.92. Positive and negative likelihood ratios ranged from 1.91 to 9.09 and from 0.29 to 0.83, respectively [93]. Many studies suggested that SFH is not suitable for primary screening of low birth weight or small for gestational age [94].

Traditionally SFH measurement is considered as simple, reliable, and inexpensive and requires little training. It is less accurate in obese and has a limitation of interobserver variation .Customised growth charts are considered better because they are able to differentiate between constitutional and pathologic smallness [95].

ULTRASOUND MEASUREMENTS-FETAL BIOMETRY

48(48.0%) babies had AC> 10^{th} centile for gestational age compared to 52(52.0%) babies who had AC <10^{th} centile for gestational age with a mean of 32.04 and standard deviation of 3.40. A study by K. Pressman et al showed that addition of AC as a criterion for diagnosing FGR improves the ability to predict neonatal SGA [96]. Society for Maternal-Fetal Medicine guidelines have broadened the definition to include abdominal circumference (AC) <10^{th} percentile for gestational age (GA) to diagnose fetal growth restriction (FGR) regardless of estimated fetal weight (EFW).

A study by Deepti Sharma et al concluded that clinical examination as well as ultrasound biometry has limited accuracy in determining appropriate time of intervention and timely delivery in growth restricted fetuses compared to ultrasound Doppler [97].

ULTRASOUND DOPPLER PARAMETERS

Uterine artery PI

We evaluated the efficacy of ultrasound doppler parameters at 26-28 weeks, 28-32 weeks and 32-36 weeks in the prediction of FGR. Abnormal uterine artery doppler is defined as a PI which is greater than 95^{th} percentile for that gestational age. Uterine artery PI > 95^{th} centile at 26-28

weeks,28-32 weeks and 32-36 weeks was 28,12 and 2 respectively. Uterine artery PI in patients with abnormal Doppler and birth weight<10th centile i.e FGR babies was statistically significant with a p-value of 0.032 in 27(77.1%) patients. 19 out of 28 patients who had abnormal uterine artery PI at 26-28 weeks were hypertensive majority developing pre eclampsia with severe features. These results were supported by a study done by Ghi T et al which was a prospective study which compared pregnant women with nominal uterine artery blood flow at 20–22weeks and those with normal uterine artery parameters at 26–28 weeks, patients who had persistently abnormal Uterine Artery Doppler were more prone to Pre Eclampsia, SGA neonates and more admissions to NICU (p<0.005) [98].

In addition, another study found that UtA-PI done in full term Pre Eclampsia patients increased significantly only from 33 weeks, indicating that it is necessary to monitor uterine artery blood flow in the third trimester [99]. This may be the result of vasoconstriction in uterine placental circulation just before the onset of the disease, instead of the defective placentation at early pregnancy.

A recent nested case control study done in 2020 by Obican SG et al observed that patients with diastolic notch in the left uterine artery and a PI greater than the 95th percentile were at an elevated risk of pregnancy complications [100].

In our study one patient who developed hypertension had persistently abnormal uterine artery PI resulting in FGR baby which also had perinatal complications like severe RDS, neonatal hyperbilirubinemia and NEC. These results were supported by a study which did sequential detection of uterine artery Doppler suggested that pregnant women with persistently elevated UtA-PI were at the greatest risk for gestational hypertension and FGR [101].

Umbilical artery Doppler

An abnormal umbilical artery Doppler is defined as a PI, RI,or S/D ratio which is greater than the 95th percentile for that gestational age or having an absent or reversed end-diastolic velocity (AEDV or REDV). Umbilical artery PI > 95th centile at 26-28 weeks,28-32 weeks and 32-36 weeks was 31,42 and 31 respectively. Umbilical artery S/D was raised 31, 38 and 25 patients at 26-28 weeks, 28-32 weeks and 32-36 weeks respectively. Umbilical artery AEDF was present in 5, 3 and 3 patients at 26-28 weeks, 28-32 weeks and 32-36 weeks respectively. Umbilical artery REDF was present in 2, 2 and 3 patients at 26-28 weeks, 28-32 weeks and 32-36 weeks respectively. Umbilical artery S/D ratio was abnormal in 45(76.3%) FGR babies i.e had birth weight <10th centile for that gestational age and an abnormal umbilical artery S/D ratio with a p value of 0.001 which is statistically significant. 4 out of 5 babies which had AEDF in 26-28 weeks underwent cesarean delivery, had more perinatal complications like moderate RDS and NEC with 2 babies undergoing neonatal death. Both babies having REDF at 26-28 weeks were delivered by cesarean delivery out of which one had severe RDS and NEC with both babies admitted to NICU. Similar case scenarios were observed at 28-32 weeks and 32-36 weeks.

In our study patients with persistently abnormal umbilical artery PI had poor perinatal outcomes supported by study done by Jyoti Yadav et al suggesting that out of all indices Umbilical Artery PI had the highest sensitivity, PPV and good accuracy with less false positive rates in managing high risk pregnancy [102].

As seen in the same study by Jyoti Yadav et al which revealed that absent or reversed end diastolic flow in the umbilical artery has a strong association with major perinatal morbidity with mortality with a high perinatal mortality of 66.66% was noted with AEDF compared to 100% perinatal mortality noted in patients with REDF. [102]

In a recent study conducted in 2020 by Tolu LB et al observed that abnormal umbilical artery Doppler waveform is associated with increased rates of cesarean section delivery, neonatal intensive care unit admission, respiratory distress syndrome, neonatal sepsis, neonatal hyperbilirubinemia, and early neonatal death as compared to normal umbilical artery Doppler flow [103].

In a study conducted by Manoj Kumar Veerabathini et al observed that umbilical artery systolic/diastolic ratio is the most specific index (80.9%) [104].

According to latest 2020 update by society for maternal-fetal medicine, incorporating umbilical artery Doppler evaluation especially in the management of high risk pregnancies has shown to significantly reduce the risk of perinatal death and cesarean delivery making it an essential component of fetal surveillance in FGR [105, 106].

4 out of 5 babies of mothers who had AEDF at 26-28 weeks delivered by cesarean section <28 weeks due to maternal/fetal indications with all 5 babies admitted to NICU, 2 having neonatal deaths due to severe RDS and NEC and 3 out of these 5 being growth restricted.3 babies were discharged from NICU suggesting timely delivery helped in survival of these neonates.

Between 28-32 weeks, 3 babies had AEDF and all babies were growth restricted with one neonatal death amongst them with other 2 surviving perinatal complications like mild RDS and NEC-I and IIB.

Middle cerebral artery Doppler

MCA-PI <5th centile for that gestational age is considered abnormal.

In our study, 15, 22 and 28 patients had abnormal MCA-PI at 26-28 weeks, 28-32 weeks and 32-36 weeks. Our results were supported by a study which is among the first few studies which focused on SGA

predicting values for MCA and UA-PI consisted of 126 SGA cases, showing a decrease in MCA PI was statistically more notable than changes in UA PI (40.5% vs. 22.2%, respectively) with Sensitivity, specificity and predictive values of MCA PI for SGA prediction was higher than those for UA PI [107] suggesting that alterations in cerebral circulation are more sensitive to changes in the systemic circulation, hence predicting the condition of the fetus [108].

In our study babies who had abnormal MCA-PI had more admissions to NICU and were low birth weight which was similar to findings of the above mentioned study [107].

Study by Ibrahim et al. also revealed a lower MCA-PI value as a highly specific marker for predicting FGR and fetal demise [109].

Results of our study also showed false positive (23.5%) and false negative (34.4%) results regarding the birth weight and ultrasound Doppler done at 26-28 weeks, 28-32 weeks and 32-36 weeks which were similar to a study by Williams et al. Who demonstrated that there were about 20% false positives and 20% false negatives in sonographic estimation of fetal weight [110].

Pregnancy complications

In our study majority of patients with FGR babies had hypertension i.e. 32(58.2%) patients who presented between 26-28 weeks,29(51.8%) patients who presented between 28-32 weeks and 23(63.9%) patients who presented between 32-36 weeks. Other patients had anemia, cardiac disease, thyroid disorders, cytomegalovirus IgM positive, SLE, pregestational diabetics, SUA, maternal nutritional deficiency. Similar findings were observed in a study by Manoj Kumar Veerabathini et al suggesting that Hypertensive disorders were present in maximum of 50% of pregnancies complicated with FGR [111].Chromosomal disorders and

congenital malformations are found in approximately 20% of FGR cases [112, 113].

In a case report by Ibrahim A. Abdelazim et al in 2019 observing that fetuses with single umbilical artery (SUA) were at a greater risk of fetal growth restriction(FGR), intrauterine fetal death (IUFD) and prematurity[114].

In a latest 2021 study by AnneteNjue et al observed that Human cytomegalovirus (CMV) is a major cause of nonhereditary adverse birth outcomes, which includes neurologic deficits, FGR, and contributes to outcomes such as stillbirth and preterm delivery [115].

There is an association of maternal vitamin D deficiency with increased risk of FGR as studied by Chen et al [116].

TIMING OF DELIVERY

In our study 9(9.0%) patients delivered <28 weeks out of which all 9 had abnormal Doppler ultrasound and 6(66.7%) were growth restricted and neonatal death of 4(44.4%) babies , 28(28.0%) patients delivered between 28-32 weeks out of which 19(82.6%) babies had FGR and neonatal death of 2(8.7%) babies, 30(30.0%) patients delivered between 32-36 weeks out of which 12(75.0%) babies had FGR with neonatal death of 2(12.5%) babies and 33(33.0%) patients delivered >37 weeks out of which 15(75.0%) babies had FGR with no neonatal deaths. Serial Doppler ultrasound evaluation done at 26-28 weeks, 28-32 weeks and 32-36 weeks helped in taking decisions regarding the optimal timing of delivery so as to have a successful perinatal outcome.

It has been shown that the single most important prognostic factor in fetuses that are preterm and growth restricted is the gestational age at delivery [117, 118].

A longitudinal cohort study done on FGR showed an increase of intact survival of 1%-2% for every additional day the baby spent in utero until 32weeks of gestation [118] which was seen in our study that patients who delivered <32 weeks had more NICU admissions, more perinatal complications with a longer NICU stay.

According to a latest study done by Andrea Dall' Asta et al suggesting that the only treatment option in case of growth restricted fetuses is represented by a timed delivery, i.e., required when the risk of intrauterine compromise outweighs that of prematurity[119].

Mode of delivery

In our study, 46 patients underwent cesarean delivery having abnormal Doppler while only 22 patients underwent vaginal delivery in patients with abnormal Doppler. Also those who delivered vaginally were more of multiparous women. Similar results were seen in a a study by JiHye Jo et al who observed that abnormal MCA-PI/UA-PI with abnormal PI of Umbilical Artery increases the risk of cesarean delivery for non-reassuring fetal status, in fetuses with severe SGA of late preterm and term[120].

A study by Anna Fuchs DO et al concluded that abnormal umbilical artery Doppler was associated with an increased risk of cesarean delivery in women with fetal growth restriction [121]. This can be explained by the fact that growth restricted babies had more non-reassuring fetal heart rate compared to normal babies.

Birth weight and ultrasound Doppler

6 babies who delivered <28 weeks had abnormal doppler and birth weight<10th centile for gestational age. Similarly 19 babies who delivered between 28-32 weeks, 12 babies who delivered between 32-36 weeks and 15 babies who delivered >37 weeks had abnormal doppler as well as birth weight <10th centile making a total of 52 babies with true fetal growth

restriction. 21(65.6%) babies had normal doppler with birth weight >10th centile, 11(34.4%) babies had normal doppler with babies having birth weight <10th centile and 16(23.5%) babies had an abnormal doppler with babies having birth weight >10th centile.

Similar findings were observed in a study by Heera Shenoy T. et al who observed that the mean birth weight in Doppler abnormal FGR babies was 272.34 g lesser than in those with Doppler normal group babies with a p value-0.001 and that the growth restricted low birth weight neonates also had Doppler pattern abnormalities with a p-value-0.0009 which is statistically significant [122].

APGAR SCORE AT 1MIN AND 5MIN

10(10.0%) babies had a low APGAR score at 1 min i.e. between 4-7 out of which majority were FGR babies. Rest 90(90.0%) babies had an APGAR score at 1 min >7. APGAR score at 5 min for 10(10.0%) FGR babies was <7 but majority of babies had a 5 minute APGAR >7 but with a statistically insignificant p-value. The results were similar to a study done by Vikram Patil et al who observed that abnormal MCA-PI/UA-PI was associated with low 5 min APGAR scores and more NICU admissions[123]. Another study by TemesgenWorkuGudayu et al observed in his study that the proportion of low 5th minute Apgar score in his study was 13.8% with low birth weight as a factor which was significantly associated with it [124].

NICU admissions

42(80.8%) babies out of 52 FGR babies were admitted to NICU with a p-value of 0.001 which was statistically significant especially those with AEDF/REDF. Similar results were seen in a study by J.P Padma et al suggesting that the rate of intensive care unit admissions were significantly higher in absent or reversal in diastolic flow (A/REDF) group when compared to the forward end diastolic flow (FEDF) group [125].

Indications of NICU admission

In our study, there were a total of 58 NICU admissions out of which 35(83.3%) FGR babies were admitted i/v/o prematurity, 35(83.3%) FGR babies were admitted i/v/o abnormal Doppler with a p-value of 0.001 which is statistically significant and 3(7.1%) FGR babies were admitted i/v/o increased rates of breathing. Similar results were seen in a study by HeeraShenoy e al who observed that preterm and premature babies had a longer NICU stay and were amongst one of the major reasons for NICU admission along with low birth weight and birth asphyxia [122].

Prediction of perinatal outcome and perinatal complications.

50.0% fetuses had RDS, 26.9% had neonatal hyperbilirubinemia and 21.2% fetuses had NEC amongst the FGR babies. There were a total of 8 neonatal deaths in our study out of which 6 neonatal deaths were from FGR babies out of which one was an early neonatal death (<7 days). Those neonates with AEDF, REDF, severe RDS and other adverse perinatal complications had poor neonatal outcomes and neonatal deaths.

In a study which compared pregnancies In which no Doppler ultrasound evaluation was done, the use of Doppler surveillance resulted in fewer admissions to hospital (odds ratio 0.56, 95% CI 0.43–0.72) and lesser inductions of labour (odds ratio 0.83, 95% CI 0.74–0.93) with a promising trend towards reduction in perinatal death was also noted (odds ratio 0.71, 95% CI 0.5–1.0)[126].

Neonatal deaths

In our study, there were total 8 neonatal deaths out of which 6 were growth restricted i.e had abnormal Doppler as well as birth weight <10th centile for that gestational age. 4 babies had NEC-I, 4 babies had neonatal hyperbilirubinemia, all 8 babies had RDS either mild/ moderate/severe, all 8 were admitted in NICU due to prematurity and

abnormal Doppler. One baby had AEDF and one had REDF. Two babies who had abnormal doppler but were AGA out of which one baby was diagnosed with hirschsprung disease and one baby had cardiovascular defect which explains the false positive results in babies with abnormal doppler. Both these babies delivered between 32-36 weeks. Neonatal deaths were less in our study of 100 patients due to effective fetal surveillance through serial ultrasound Doppler evaluation and the results were similar to a study done by C. Lees et al who observed that fetal outcome in their study was better than expected compared to contemporary reports i.e. perinatal death was uncommon (8%) and 70% babies survived without severe neonatal morbidity [127].

CEREBROPLACENTAL RATIO

Cerebroplacental ratio was abnormal i.e. <1 in small for gestational age babies and those with abnormal Doppler. Majority of neonates having NICU admissions with more neonatal adverse outcome like RDS in such babies with one neonatal death. The p-value of this result in our study was statistically insignificant suggesting no added advantage of calculating CPR was found in our study to predict FGR and adverse neonatal outcome over other parameters like umbilical artery Doppler (PI) and middle cerebral artery PI measured alone. These findings were supported by one of the largest trial to date by PORTO which observed that irrespective of the CPR calculation, brain sparing was significantly associated with an adverse perinatal outcome in FGR babies [128]. In a latest 2021 prospective study conducted on women between 26-36 weeks of gestation showed that CPR did not improve the ability to predict neonatal SGA or other short-term adverse outcomes in FGR babies [129].

Our decision for monitoring patients diagnosed with FGR during pregnancy and their timing of delivery was based on Barcelona Stage based classification and management of FGR [130].

TABLE 47. Barcelona Stage Based Classification and Management of FGR.

Stage	Pathophysiological correlate	Criteria (any of)	Monitoring	GA/mode of delivery
I	Severe smallness or mild placental insufficiency	EFW<3RD centile CPR<5th centile UA PI> p95 Ut A PI> p95 MCA PI<P5	Weekly	37 weeks LI
II	Severe placental insufficiency	UA AEDV	Biweekly	34 weeks CS
III	Low-suspicion fetal acidosis	UA REDV DV-PI >p95	1–2 days	30 weeks CS
IV	High-suspicion fetal acidosis	DV reverse a flow	12 h	26 weeks** CS

In our study Ductus venosus Doppler was performed in a few patients who reached term as for others an early decision for delivery was taken in view of either obstetric indication or deterioration of maternal condition or fetal indication.

SUMMARY AND CONCLUSION

This was a prospective study conducted in department of obstetrics and gynaecology, DMCH, Ludhiana. In our study, a total of 100 antenatal patients were recruited who attended antenatal clinic or were admitted in antenatal ward at DMCH, Ludhiana and were subjected to USG fetal well-being and Doppler at 26-28 weeks, 28-32 weeks and 32-36 weeks gestation to evaluate the role of serial ultrasound Doppler flow parameters starting from 26 weeks in prediction and early detection of fetal growth restriction and taking timely intervention to improve perinatal outcomes.

1. A total of 100 patients were recruited on a random basis that attended antenatal OPD or were admitted at in labour ward at DMCH.
2. Out of 100 patients the minimum age was 22 year while maximum age was 55. Majority of patients were in 26- 30 years in with the mean age of 28.81.
3. Out of 100 patients 64(64.0%) were primigravida and 36(36.0%) were multigravida. Majority of patients were primigravida.
4. Out of 100 patients, majority of the patients were employed in our study.
5. Majority of patients belonged to urban areas in our study.
6. Out of 100 patients, 60(60.0%) patients were graduate, 19(19.0%) were postgraduate and 21(21.0%) were undergraduate. Majority of patients belonged to graduate group.
7. Out of 100 patients, majority i.e. 78(78.0%) patients had symphysiofundal height corresponding to period of gestation. When comparison of women according to SFH and abnormal doppler was done at 26-28 weeks, 28-32 weeks and 32-36 weeks, it was statistically significant in all 3 groups with p-values of 0.001, 0.006 and 0.038 respectively.

8. In our study, the most common maternal complicating factor in pregnancy was hypertension at all 3 period of gestations. The other risk factors being SUA, maternal thyroid disorders, SLE, cytomegalovirus, anemia and maternal nutritional deficiency.
9. In our study out of 100 patients, 59(59.0%) patients underwent cesarean delivery out of which majority were with abnormal doppler and babies turned out growth restricted compared to 41(41.0%) patients who underwent vaginal delivery.
10. In our study, uterine artery PI >95th centile which is considered abnormal was 28,12 and 2 at 26-28 weeks, 28-32 weeks and 32-36 weeks respectively. Uterine artery PI was abnormal in 27(77.1%) babies with birth weight <10th centile for gestational age with a p-value of 0.032 which is statistically significant.
11. In our study, UA-S/D ratio was statistically significant in patients with abnormal UA-S/D ratio and babies born with birth weight<10th centile for gestational age with a p-value of 0.001.
12. Majority of MCA-PI was abnormal i.e. <5th centile in patients who presented at 32-36 weeks i.e. helped in diagnosis of late onset FGR because fetal cerebral circulation is more sensitive to fetal hypoxia than umblical artery.
13. Majority i.e. 33(33.0%) patients delivered >37 weeks as serial ultrasound doppler helped in taking decision for optimal timing of delivery and when the risk of intrauterine compromise outweighs that of prematurity.
14. Majority of babies had birth weight <10th centile for gestational age with majority of them requiring NICU admission due to prematurity and low birth weight. Majority of them had normal APGAR score at 1 and 5 min.
15. Growth restricted low birth weight neonates had abnormalities i.e. had true growth restriction in 52(76.5%) babies with a p-value of 0.001 which was statistically significant.

16. AEDF and REDF are associated with extremely high rates of perinatal morbidity and mortality.
17. There were a total of 8 neonatal deaths in our study suggesting that serial doppler evaluation helped in improving perinatal outcome.
18. Serial measurement of Uterine Artery PI , umbilical artery PI and Umbilical Artery S/D ratio starting from 26 weeks helped in prediction of FGR babies and take decision for timely delivery so as to improve perinatal outcome.
19. Cerebroplacental ratio did not give any added advantage over prediction of FGR over Ut-A PI and MCA-PI alone.
20. MCA-PI abnormality was more in third trimester suggesting that late onset FGR can be predicted with use of MCA-PI as it suggests fetal hypoxia.
21. Abnormal Doppler velocimetry was significantly associated with earlier FGR detection, shorter decision to delivery interval, reduction in the mean birth weight and a longer NICU stay. Hence, uterine artery doppler ,Umbilical artery Doppler and MCA doppler is an integral part of in-utero fetal surveillance in order to identify impending fetal hypoxia, plan appropriate management, to optimize the timing of delivery and improve perinatal health in FGR babies.

BIBLIOGRAPHY

1. Martin JA, Hamilton BE, Ventura SJ, Osterman MJ, Wilson EC, Mathews TJ. Births: final data for 2010. Natl Vital Stat Rep.2012;61:1-72.
2. American College of O, Gynecologists. ACOG Practice Bulletin No.134: fetal growth restriction. Obstet Gynecol 2013;121:1122–33.
3. Sharma D, Shastri S, Sharma P. Intrauterine growthrestriction: antenatal and postnatal aspects. Clin MedInsights Pediatr. 2016;10:67-83.
4. Veerabathini MK, Mohanthy SS, Mukherjee N, Adarsh A, Kumar BA, Shankar G. Role of color Doppler in the evaluation of intrauterine growth retardation. International Journal of Contemporary Medicine Surgery and Radiology. 2020;5:A148-52.
5. Biswas S, Biswas S. Radiology in IUGR: a study. ARC journal of obstetrics and gynecology. 2017;2:20-34.
6. J. S. Dashe, D. D. McIntire, M. J. Lucas, and K. J. Leveno, “Effects of symmetric and asymmetric fetal growth on pregnancy outcomes,” Obstetrics and Gynecology, vol. 96, no.3, pp. 321–327, 2000.
7. Alberry M, Soothill P. Management of growth restriction. Archives Disease and Childhood, Fetal and Neonatal Edition. 2007;72:F62-F7.
8. Sheridan C. Intrauterine growth restriction. Australian Family Physician. 2005;34:717-23.
9. Baschat AA. Arterial and venous Doppler in the diagnosis and management of early onset fetal growth restriction. Early human development. 2005 1;81:877-87.
10. Bilardo CM, Wolf H, Stigter RH, Ville Y, Baez E, Visser GH, et al. Relationship between monitoring parameters and perinatal outcome in severe, early intrauterine growth restriction. Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2004;23:119-25.

11. Royal College of Obstetricians & Gynaecologists. Smallfor gestational age fetus: investigation and management.Green-top Guideline. 2013.
12. W. J. Ott, “Intrauterine growth restriction and Doppler ultrasonography” Journal of Ultrasound in Medicine, vol. 19, no. 10, pp. 661–665, 2000.
13. Fitzgerald DE, Drumm JE. Non-invasive measurement of the human circulation using ultrasound: a new method. BMJ. 1977;2:1450–1.
14. Campbell S, Vyas S, Nicolaides KH. Doppler investigation of the fetal circulation.
15. Mari G, Uerpairojkit B, Abuhamad AZ, Copel JA. Adrenal artery velocity waveforms in the appropriate and small-for-gestational-age fetus. Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 1996;8:82-6.
16. Abuhamad AZ, Mari G, Bogdan D, Evans III AT. Doppler flow velocimetry of the splenic artery in the human fetus: is it a marker of chronic hypoxia?. American journal of obstetrics and gynecology. 1995;172:820-5.
17 Hecher K, Campbell S, Doyle P, Harrington K, Nicolaides K. Assessment of fetal compromise by Doppler ultrasound investigation of the fetal circulation: arterial, intracardiac, and venous blood flow velocity studies. Circulation. 1995;91:129-38.
18. Baschat AA, Gembruch U, Reiss I, Gortner L, Weiner CP, Harman CR. Relationship between arterial and venous Doppler and perinatal outcome in fetal growth restriction. Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2000;16:407-13.
19. Veerabathini MK, Mohanthy SS, Mukherjee N, Adarsh A, Kumar BA, Shankar G. Role of color Doppler in the evaluation of intrauterine growth retardation. International Journal of Contemporary Medicine Surgery and Radiology. 2020;5:A148-52.

20. Veerabathini MK, Mohanthy SS, Mukherjee N, Adarsh A, Kumar BA, Shankar G. Role of color Doppler in the evaluation of intrauterine growth retardation. International Journal of Contemporary Medicine Surgery and Radiology. 2020;5:A148-52
21 Bahtiyar MO, Copel JA. Doppler ultrasound: select fetal andmaternal applications. In: Creasy RK, Resnik R, Greene MF,Iams JD, Lockwood CJ, eds. Creasy and Resnik's maternal-fetal medicine: principles and practice. 7th ed. Philadelphia,Pa: Elsevier/Saunders, 2014; 211–217.
22. Royal College of Obstetricians & Gynaecologists. Small for gestational age fetus:investigation and management.Green-top Guideline. 2013.
23. Deshmukh P, Soni PK, Kankoriya A, Halve AK, Dixit R. 4-Aminoantipyrine: A significant tool for the synthesis of biologically active Schiff bases and metal complexes. Int. J. Pharm. Sci. Rev. Res. 2015;34:162-70.
24. Resnik R. Intrauterine growth restriction. Obstetrics & Gynecology. 2002 ;99:490-6.
25. Lee AC, Kozuki N, Cousens S, Stevens GA, Blencowe H, Silveira MF, Sania A, Rosen HE, Schmiegelow C, Adair LS, Baqui AH. Estimates of burden and consequences of infants born small for gestational age in low and middle income countries with INTERGROWTH-21st standard: analysis of CHERG datasets. bmj. 2017:17;358.
26. Chauhan SP, Beydoun H, Chang E, Sandlin AT, Dahlke JD, Igwe E et al. Prenatal detection of fetal growth restriction in newborns classified as small for gestational age: correlates and risk of neonatal morbidity. American journal of perinatology. 2014;31:187-94.
27. Gardosi J, Madurasinghe V, Williams M, Malik A, Francis A. Maternal and fetal risk factors for stillbirth: population based study. Bmj. 2013;346.
28. Unterscheider J, O'Donoghue K, Daly S, Geary MP, Kennelly MM, McAuliffe FM, et al. Fetal growth restriction and the risk of perinatal

mortality–case studies from the multicentre PORTO study. BMC pregnancy and childbirth. 2014;14:1-6.

29. Figueras F, Gratacós E. Update on the diagnosis and classification of fetal growth restriction and proposal of a stage-based management protocol. Fetal diagnosis and therapy. 2014;36:86-98.
30. Mifsud W, Sebire NJ. Placental pathology in early-onset and late-onset fetal growth restriction. Fetal diagnosis and therapy. 2014;36:117-28.
31. Aviram A, Sherman C, Kingdom J, Zaltz A, Barrett J, Melamed N. Defining early vs late fetal growth restriction by placental pathology. Acta obstetricia et gynecologica Scandinavica. 2019;98:365-73.
32. Dall'Asta A, Brunelli V, Prefumo F, Frusca T, Lees CC. Early onset fetal growth restriction. Maternal health, neonatology and perinatology. 2017 Dec;3:1-2.
33. Unterscheider J, Daly S, Geary MP, Kennelly MM, McAuliffe FM, O'Donoghue K, et al. Optimizing the definition of intrauterine growth restriction: the multicenter prospective PORTO Study. American journal of obstetrics and gynecology. 2013;208:290-e1.
34. Finken MJ, van der Steen M, Smeets CC, Walenkamp MJ, de Bruin C, Hokken –Koelega AC, et al. Children born small for gestatational age: differential diagnosis , molecular genetic evaluation, and implications. Endocrine reviews.2018;39:851-94.
35. Ghidini A. Idiopathic fetal growth restriction: a pathophysiologic approach. Obstetrical & gynecological survey. 1996;51:376-82.
36. Malhotra A, Allison BJ, Castillo-Melendez M, Jenkin G, Polglase GR, Miller SL. Neonatal morbidities of fetal growth restriction: pathophysiology and impact. Frontiers in endocrinology. 2019;10:55.
37. Woods KA, Camacho –HubnerC , Savage MO , Clark AJ: Intrauterine growth retardation and postnatal growth failure associated with deletion of insulin –like growth factor I gene. N Engl J Med. 1996;335:1363-67.

38. Maulik DE. Fetal growth restriction: the etiology. Clinical obstetrics and gynecology. 2006;49:228-35.
39. Nardozza LM, Caetano AC, Zamarian AC, Mazzola JB, Silva CP, Marçal VM, et al. Fetal growth restriction: current knowledge. Archives of gynecology and obstetrics. 2017;295:1061-77.
40. Melamed N, Baschat A, Yinon Y, Athanasiadis A, Mecacci F, Figueras F, et al. FIGO (international Federation of Gynecology and obstetrics) initiative on fetal growth: best practice advice for screening, diagnosis, and management of fetal growth restriction. International Journal of Gynaecology and Obstetrics. 2021;152:3.
41. Quinn JA, Munoz FM, Gonik B, Frau L, Cutland C, Mallett-Moore T, et al. Preterm birth: Case definition & guidelines for data collection, analysis, and presentation of immunisation safety data. Vaccine. 2016;34:6047-56.
42. Harrison MS, Eckert LO, Cutland C, Gravett M, Harper DM, McClure EM, et al. Pathways to preterm birth: case definition and guidelines for data collection, analysis, and presentation of immunization safety data. Vaccine. 2016;34:6093.
43. Saenger P, Czernichow P, Hughes I, Reiter EO. Small for gestational age: short stature and beyond. Endocr Rev. 2007;28:219-51.
44. Gardosi J, Madurasinghe V, Williams M, Malik A, Francis A. Maternal and fetal risk factors for stillbirth: population based study. BMJ. 2013;346:f108.
45. Hiersch L, Lipworth H, Kingdom J, Barrett J, Melamed N. Identification of the optimal growth chart and threshold for the prediction of antepartum stillbirth. Archives of Gynecology and Obstetrics. 2021;303:381-90.
46. Temming LA, Jeffrey M, Stout MJ, Rampersad RM, Macones GA, Tuuli MG, et al. Early second-trimester fetal growth restriction and adverse perinatal outcomes. Obstetrics and gynecology. 2017;130:865.

47. Lackman F, Capewell V, Richardson B, Gagnon R. The risks of spontaneous preterm delivery and perinatal mortality in relation to size at birth according to fetal versus neonatal growth standards. American journal of obstetrics and gynecology. 2001;184:946-53.
48. Figueras F, Gratacos E. An integrated approach to fetal growth restriction. Best practice & research Clinical obstetrics & gynaecology. 2017;38:48-58.
49. Proctor LK, Kfouri J, Hiersch L, Aviram A, Zaltz A, Kingdom J, et al. Association between hypertensive disorders and fetal growth restriction in twin compared with singleton gestations. American Journal of Obstetrics and Gynecology. 2019;221:51-e1.
50. Figueras F, Oros D, Cruz-Martinez R, Padilla N, Hernandez-Andrade E, Botet F, et al. Neurobehavior in term, small-for-gestational age infants with normal placental function. Pediatrics. 2009;124:e934-41.
51. Barker DJ. Adult consequences of fetal growth restriction. Clinical obstetrics and gynecology. 2006;49:270-83.
52. Baschat AA. Pathophysiology of fetal growth restriction: implications for diagnosis and surveillance. Obstetrical & gynecological survey. 2004;59:617-27.
53. Sciscione AC, Hayes EJ. Uterine artery Doppler flow studies in obstetric practice. American journal of obstetrics and gynecology. 2009;201:121-6.
54. Khalil A, Morales-Roselló J, Townsend R, Morlando M, Papageorghiou A, Bhide A, Thilaganathan B. Value of third-trimester cerebroplacental ratio and uterine artery Doppler indices as predictors of stillbirth and perinatal loss. Ultrasound in Obstetrics & Gynecology. 2016;47:74-80.
55. Conde-Agudelo A, Bird S, Kennedy SH, Villar J, Papageorghiou AT. First-and second-trimester tests to predict stillbirth in unselected pregnant women: a systematic review and meta-analysis. BJOG: An International Journal of Obstetrics & Gynaecology. 2015;122:41-55.

56. Papageorghiou AT, Roberts N. Uterine artery Doppler screening for adverse pregnancy outcome. Current Opinion in Obstetrics and Gynecology. 2005 ;17:584-90.
57. Papageorghiou AT, Yu CK, Cicero S, Bower S, Nicolaides KH. Second-trimester uterine artery Doppler screening in unselected populations: a review. The Journal of Maternal-Fetal & Neonatal Medicine. 2002;12:78-88.
58. Papageorghiou AT, Yu CK, Bindra R, Pandis G, Nicolaides KH. Multicenter screening for pre-eclampsia and fetal growth restriction by transvaginal uterine artery Doppler at 23 weeks of gestation. Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2001;18:441-9.
59. Poon LC, Lesmes C, Gallo DM, Akolekar R, Nicolaides KH. Prediction of small-for-gestational-age neonates: screening by biophysical and biochemical markers at 19-24 weeks. Ultrasound Obstetrics and Gynecology
2015;46:437–45.
60. Levytska K, Higgins M, Keating S,. Placental Pathology in Relation to Uterine Artery Doppler Findings in Pregnancies with Severe
Intrauterine Growth Restriction and Abnormal Umbilical Artery Doppler Changes. Am J Perinatol 2017;34:451–7.
61. Roberts LA, Ling HZ, Poon LC, Nicolaides KH, Kametas NA. Maternal hemodynamics, fetal biometry and Doppler indices in pregnancies followed up for suspected fetal growth restriction. Ultrasound Obstet Gynecol 2018;52:507–14.
62. Chien PF, Arnott N, Gordon A, Owen P, Khan KS. How useful is uterine artery Doppler flow velocimetry in the prediction of pre-eclampsia,

intrauterine growth retardation and perinatal death? An overview. Bjog 2000;107:196–208.

63. Parry S, Sciscione A, Haas DM, et al. Role of early second-trimester uterine artery Doppler screening to predict small-for-gestational-age babies in nulliparous women. Am J ObstetGynecol 2017;217:594.e1–10.
64. Peixoto AB, Caldas TM, Tonni G, Morelli PD, Santos LD, Martins WP, Júnior EA. Reference range for uterine artery Doppler pulsatility index using transvaginal ultrasound at 20–24w6d of gestation in a low-risk Brazilian population. Journal of the Turkish German Gynecological Association. 2016;17:16.
65. Srikumar S, Debnath J, Ravikumar R, Bandhu HC, Maurya VK. Doppler indices of the umbilical and fetal middle cerebral artery at 18–40 weeks of normal gestation: A pilot study. Medical Journal Armed Forces India. 2017;73:232-41.
66. Trudinger BJ. Doppler ultrasonography and fetal well-being. In: Reece EA, Hobbins JC, Mahoney M, Petrie RH, eds. Medicine of the Fetus
and Mother. Philadelphia, PA: JB Lippincott Co; 1992.
67. McCowan LM, Harding JE, Roberts AB, Barker SE, Ford C, Stewart AW. A pilot randomized controlled trial of two regimens of fetal surveillance for small-for-gestational-age fetuses with normal results of umbilical artery dopplervelocimetry. Am J ObstetGynecol 2000;182: 81–6.
68. Alfirevic Z, Stampalija T, Dowswell T. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. Cochrane Database Syst Rev 2017;6:
Cd007529.
69. Caradeux J, Martinez-Portilla RJ, Basuki TR, Kiserud T, Figueras F. Risk of fetal death in growth-restricted fetuses with umbilical and/or ductus venosus absent or reversed end-diastolic velocities before 34 weeks of

gestation: a systematic review and meta-analysis. Am J ObstetGynecol 2018;218:S774–82.e21.

70. Lees C, Marlow N, Arabin B, et al. Perinatal morbidity and mortality in early-onset fetal growth restriction: cohort outcomes of the trial of randomized umbilical and fetal flow in Europe (TRUFFLE). Ultrasound Obstet Gynecol 2013;42:400–8.
71. Turan OM, Turan S, Gungor S, et al. Progression of Doppler abnormalities in intrauterine growth restriction. Ultrasound ObstetGynecol 2008;32:160–7.
72. Radswiki T, Weerakkody Y, El-Feky M,. Umbilical arterial Doppler assessment. Reference article, Radiopaedia.org 2023.
73. Okochi OD, Isah AY, Kolade-Yunusa HO, Abdullahi HI. Umbilical artery Doppler reference indices in normal pregnancy. J Radiat Med Trop 2021;2:79-85
74 Veille JC, Hanson R, Tatum K. Longitudinal quantitation of middle cerebral artery blood flow in normal human fetuses. Am J ObstetGynecol
1993;169:1393–8.
75. Mari G, Abuhamad AZ, Cosmi E, Segata M, Altaye M, Akiyama M. Middle cerebral artery peak systolic velocity: technique and variability. J Ultrasound Med 2005;24:425–30.
76. Baschat AA, Gembruch U. The cerebroplacental Doppler ratio revisited. Ultrasound ObstetGynecol 2003;21:124–7.
77. Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A. Cerebral-umbilical Doppler ratio as a predictor of adverse perinatal outcome. Obstet Gynecol 1992;79:416–20.
78. Odibo AO, Riddick C, Pare E, Stamilio DM, Macones GA. Cerebroplacental Doppler ratio and adverse perinatal outcomes in intrauterine growth restriction: evaluating the impact of using gestational age-specific reference values. J Ultrasound Med 2005;24:1223–8.

79. Stampalija T, Arabin B, Wolf H, Bilardo CM, Lees C. Is middle cerebral artery Doppler related to neonatal and 2-year infant outcome in early fetal growth restriction? Am J ObstetGynecol 2017;216:521.e1–13.
80. Flood K, Unterscheider J, Daly S, et al. The role of brain sparing in the prediction of adverse outcomes in intrauterine growth restriction: results of the multicenter PORTO Study. Am J ObstetGynecol 2014;211:288.e1–5..
81. Srikumar S, Debnath J, Ravikumar R, Bandhu HC, Maurya VK. Doppler indices of the umbilical and fetal middle cerebral artery at 18–40 weeks of normal gestation: A pilot study. Medical Journal Armed Forces India. 2017;73:232-41.
82. Kehl S, Zaiss I, Freiburg F, Speierer A, Sütterlin M, Siemer J. Comparison of different sonographic methods to determine foetal abdominal circumference. FoetalDiagnTher. 2010;28:201-6.
83. Gotsch F, Cruciani L, Ghezzi F, Ogge G, Yeo L, Romero R: Doppler interrogation of the foetal circulation; in Fleischer AC, Toy EC, Lee W, Manning FA, Romero R (eds): Sonography in Obstetrics and Gynecology, ed 7. New York, McGraw Hill, 2011, pp 257–308.
84. Muhihi A, Sudfeld CR, Smith ER, Noor RA, Mshamu S, Briegleb C, et al. Risk factors for small-for-gestational-age and preterm births among 19,269 Tanzanian newborns. BMC pregnancy and child birth. 2016;16:1-2.
85. Palatnik A, De Cicco S, Zhang L, Simpson P, Hibbard J, Egede LE. The association between advanced maternal age and diagnosis of small for gestational age. American journal of perinatology. 2020;37:037-43.
86. Fall CH, Sachdev HS, Osmond C, Restrepo-Mendez MC, Victora C, Martorell R, et al. Association between maternal age at childbirth and child and adult outcomes in the offspring: a prospective study in five low-income and middle-income countries (COHORTS collaboration). The Lancet Global Health. 2015 ;3:e366-77.

87 Kozuki N, Lee AC, Silveira MF, Sania A, Vogel JP, Adair L, Barros et al. The associations of parity and maternal age with small-for-gestational-age, preterm, and neonatal and infant mortality: a meta-analysis. BMC public health. 2013;13:1-0.

88. Lamminpää R, Vehviläinen-Julkunen K, Gissler M, Heinonen S. Preeclampsia complicated by advanced maternal age: a registry-based study on primiparous women in Finland 1997–2008. BMC pregnancy and childbirth. 2012;12:1-5.

89. Moh W, Graham JM, Wadhawan I, Sanchez-Lara PA. Extrinsic factors influencing fetal deformations and intrauterine growth restriction. Journal of pregnancy. 2012;2012.

90 Albu AR, Anca AF, Horhoianu VV, Horhoianu IA. Predictive factors for intrauterine growth restriction. Journal of medicine and life. 2014;7:165.

91. Saleem T, Sajjad N, Fatima S, Habib N, Ali SR, Qadir M. Intrauterine growth retardation-small events, big consequences. Italian journal of pediatrics. 2011 ;37:1-4.

92. Sebastian T, Yadav B, Jeyaseelan L, Vijayaselvi R, Jose R. Small for gestational age births among South Indian women: temporal trend and risk factors from 1996 to 2010. BMC pregnancy and childbirth. 2015;15:1-0.

93. Pay AS, Wiik J, Backe B, Jacobsson B, Strandell A, Klovning A. Symphysis-fundus height measurement to predict small-for-gestational-age status at birth: a systematic review. BMC pregnancy and child birth. 2015;15:1-9.

94. Goto E. Prediction of low birthweight and small for gestational age from symphysis-fundal height mainly in developing countries: a meta-analysis. J Epidemiol Community Health. 2013;67:999-1005.

95. Clausson B, Gardosi J, Francis A, Cnattingius S. Perinatal outcome in SGA births defined by customised versus population-based birthweight standards. British Journal of Obstetrics and Gynaecology. 2001;108:830-4.

96. Pressman K, Odibo L, Duncan JR, Odibo AO. Impact of using abdominal circumference independently in the diagnosis of fetal growth restriction. Journal of Ultrasound in Medicine. 2022;41:157-62.
97. Sharma DD et al. Int J ReprodContraceptObstet Gynecol. 2016;5:4290-96.
98. Ghi T, Contro E, Youssef A, Giorgetta F, Farina A, Pilu G, et al. Persistence of increased uterine artery resistance in the third trimester and pregnancy outcome. Ultrasound in Obstetrics and Gynecology. 2010;36:577-81.
99. Khalil A, Garcia-Mandujano R, Maiz N, Elkhaouli M, Nicolaides KH. Longitudinal changes in uterine artery Doppler and blood pressure and risk of pre-eclampsia. Ultrasound in Obstetrics & Gynecology. 2014;43:541-7.
100. Običan SG, Odibo L, Tuuli MG, Rodriguez A, Odibo AO. Third trimester uterine artery Doppler indices as predictors of preeclampsia and neonatal small for gestational age. The Journal of Maternal-Fetal & Neonatal Medicine. 2020;33:3484-9.
101. Gomez O, Figueras F, Martinez JM, Del Rio M, Palacio M, Eixarch et al. Sequential changes in uterine artery blood flow pattern between the first and second trimesters of gestation in relation to pregnancy outcome. Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2006;28:802-8.
102. Yadav J. Int J Reproductive Contracept Obstetrics and Gynecology. 2017;6:4382-88.
103. Tolu LB, Ararso R, Abdulkadir A, Feyissa GT, Worku Y. Perinatal outcome of growth restricted fetuses with abnormal umbilical artery Doppler waveforms compared to growth restricted fetuses with normal umbilical artery Doppler waveforms at a tertiary referral hospital in urban Ethiopia. PLoS One. 2020;15:e0234810.

104. Veerabathini MK, Mohanthy SS, Mukherjee N, Adarsh A, Kumar BA, Shankar G. Role of color Doppler in the evaluation of intrauterine growth retardation. International Journal of Contemporary Medicine Surgery and Radiology. 2020;5:A148-52.
105. McCowan LM, Harding JE, Roberts AB, Barker SE, Ford C, Stewart AW. A pilot randomized controlled trial of two regimens of fetal surveillance for small-for-gestational-age fetuses with normal results of umbilical artery doppler velocimetry. American journal of obstetrics and gynecology. 2000;182:81-6.
106. Alfirevic Z, Stampalija T, Dowswell T. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. Cochrane database of systematic reviews. 2017.
107. Sharbaf FR, Movahed F, Pirjani R, Teimoory N, Shariat M, Farahani Z. Comparison of fetal middle cerebral artery versus umbilical artery color Doppler ultrasound for predicting neonatal outcome in complicated pregnancies with fetal growth restriction. Biomedical research and therapy. 2018;5:2296-304.
108. TARZAMANI M, Nezami N, GATREH SF, Vahedinia S, Tarzamni M. Doppler waveform indices of fetal middle cerebral artery in normal 20 to 40 weeks pregnancies.
109. Nafees M, Ibrahim MI, Akram MH. Sensitivity and specificity of pulsatility index umbilical artery and middle cerebral artery in detecting intra uterine growth restriction. Pakistan Armed Forces Medical Journal. 2014;64:161-6.
110. Williams obstetrics, 24eCunningham F, Leveno K, Bloom S, Spong CY, Dashe JMcgraw-hill: 2014.
111. Veerabathini MK, Mohanthy SS, Mukherjee N, Adarsh A, Kumar BA, Shankar G. Role of color Doppler in the evaluation of intrauterine growth retardation. International Journal of Contemporary Medicine Surgery and Radiology. 2020;5:A148-52.

112. Bamfo JE, Odibo AO. Diagnosis and management of fetal growth restriction. Journal of pregnancy. 2011.
113. Resnik R. Intrauterine growth restriction. Obstetrics & Gynecology. 2002 ;99:490-6.
114. Abdelazim IA, Abu-Faza M, Hamed ME, Amer OO, Shikanova S, Zhurabekova G. Prenatal diagnosis of single umbilical artery complicated by intrauterine growth retardation and preterm labor: Case report. Journal of family medicine and primary care. 2019;8:2151.
115. Njue A, Coyne C, Margulis AV, Wang D, Marks MA, Russell K, Das R, Sinha A. The role of congenital cytomegalovirus infection in adverse birth outcomes: A review of the potential mechanisms. Viruses. 2020;13:20.
116. Chen YH, Fu L, Hao JH, Yu Z, Zhu P, Wang H, et al. Maternal vitamin D deficiency during pregnancy elevates the risks of small for gestational age and low birth weight infants in Chinese population. The Journal of Clinical Endocrinology & Metabolism. 2015;100:1912-9.
117. Lees C, Marlow N, Arabin B, Bilardo CM, Brezinka C, Derks JB, et al. Perinatal morbidity and mortality in early-onset fetal growth restriction: cohort outcomes of the trial of randomized umbilical and fetal flow in Europe (TRUFFLE). Ultrasound in obstetrics & gynecology. 2013;42:400-8.
118. Baschat AA, Cosmi E, Bilardo CM, Wolf H, Berg C, Rigano S, et al. Predictors of neonatal outcome in early-onset placental dysfunction. Obstetrics & Gynecology. 2007;109:253-61.
119. Dall'Asta A, Minopoli M, Ghi T, Frusca T. Monitoring, Delivery and Outcome in Early Onset Fetal Growth Restriction. Reproductive Medicine. 2021;2:85-94.
120. Jo JH, Choi YH, Wie JH, Ko HS, Park IY, Shin JC. Fetal Doppler to predict cesarean delivery for non-reassuring fetal status in the severe small-for-gestational-age fetuses of late preterm and term. Obstetrics & Gynecology Science. 2018;61:202-8.

121. Prediction of Cesarean Delivery by Umbilical Artery Dopplers in Growth Restricted Fetuses Anna Fuchs DO, Cassandra Heiselman DO, MPH, Leslie Peralta BA, VaibhaviUmesh MD, Megan Gorman MD, Kimberly Herrera MD, Omar Abuzeid MD, Jennifer Choi DO, Diana Garretto MD, David Garry DO Division of Maternal Fetal Medicine Renaissance School of Medicine at Stony Brook University, 2021.
122. Shenoy HT, James SX, Shenoy ST. Maternal risk factors and perinatal outcomes in fetal growth restriction using obstetric Doppler in South Kerala, India. Int J Reprod Contracept Obstet Gynecol. 2019;8:6-13.
123. Patil V, Gowda S, DAS S, Suma KB, Hiremath R, Shetty S, et al. Cerebro-Placental Ratio in Women with Hypertensive Disorders of Pregnancy: A Reliable Predictor of Neonatal Outcome. Journal of Clinical & Diagnostic Research. 2019;13.
124. Gudayu TW. Proportion and factors associated with low fifth minute Apgar score among singleton newborn babies in Gondar University referral hospital; North West Ethiopia. African health sciences. 2017;17:1-6.
125. Padma JP, Nayar L. Neonatal outcome of babies born to mothers with abnormal umbilical artery doppler. Current Medical Issues. 2021;19:88.
126. Wladimiroff JW, Eik-Nes S, editors. Ultrasound in obstetrics and gynaecology. Elsevier Health Sciences; 2009.
127. Lees C, Marlow N, Arabin B, Bilardo CM, Brezinka C, Derks JB, et al. Perinatal morbidity and mortality in early-onset fetal growth restriction: cohort outcomes of the trial of randomized umbilical and fetal flow in Europe (TRUFFLE). Ultrasound in obstetrics & gynecology. 2013;42:400-8.
128. Flood K, Unterscheider J, Daly S, Geary MP, Kennelly MM, McAuliffe FM, O'Donoghue K, Hunter A, Morrison JJ, Burke G, Dicker P. The role of brain sparing in the prediction of adverse outcomes in intrauterine

growth restriction: results of the multicenter PORTO Study. American journal of obstetrics and gynecology. 2014;211:288-e1.

129. Leavitt K, Odibo L, Nwabuobi C, Tuuli MG, Odibo A. The value of introducing cerebroplacental ratio (CPR) versus umbilical artery (UA) Doppler alone for the prediction of neonatal small for gestational age (SGA) and short-term adverse outcomes. The Journal of Maternal-Fetal & Neonatal Medicine. 2021;34:1565-9.

130. Figueras F, Gratacos E. Stage-based approach to the management of fetal growth restriction. Prenatal diagnosis. 2014;34:655-9.

PROFORMA

Sr. No

Name:-

Age:-<20 21-25 26-30 >30

Date of admission:-

Admission number:-

MRD number:-

Residential address:- rural urban

Education:- undergraduate graduate postgraduate

Occupation:- housewife employed

Parity:- P1 P2 P3 P>3

Booked/ Unbooked

Menstrual history:-

LMP:- date regular/irregular cycle length

EDOD:-

POG:-

- Obstetric history:-
- Risk factor of developing FGR :- Fetal causes - chromosomal/ structural / genetic abnormality

Placental causes - single umbilical artery / abnormal placental implantation / bilobed placenta

Maternal cause - nulliparity / grand multipara

HTN / renal disease / vasculapathy / autoimmune disease / DM2

Period of gestation when she developed FGR :-

Past history:-

Family history:-

Socio-economic history:-

Nutritional history:-

Period of gestation at the time of delivery:-

Mode of delivery:-

Vaginal (with forceps/ without forceps

Caesarean

- Indication of caesarean :-

Signature of Candidate **Signature of Supervisor**

- Neonatal details:-
- Date and time of birth:-

A)LIVE BIRTH

- Term/ pre-term
- Birth weight
- Sex of baby
- APGAR SCORE :- AT 1 MINS
  AT 5 MINS
- Admisssion to NICU:- YES / NO
- Indication of admission:-

B) STILL BIRTH

- Perinatal complications :-

- General physical examination:-

P/A : Fundal height : a) corresponding to POG
b) lag

INVESTIGATION:-

1. NST
2. ULTRASOUND:- AC
   BPD
   FL
   HC

Signature of Candidate **Signature of Supervisor**

DOPPLER PARAMETERS :

	26-28 weeks		
	S/D	PI	RI
Uterine Artery			
Umbilical Artery			
Middle Cerebral Artery			

	28-32 weeks		
	S/D	PI	RI
Uterine Artery			
Umbilical Artery			
Middle Cerebral Artery			

	32-36 weeks		
	S/D	PI	RI
Uterine Artery			
Umbilical Artery			
Middle Cerebral Artery			

	26-28 weeks	
	Normal	Abnormal
Cerebro Placental Ratio		
Ductusvenosus Doppler		

	28-32 weeks	
	Normal	Abnormal
Cerebro Placental Ratio		
Ductusvenosus Doppler		

	32-36 weeks	
	Normal	Abnormal
Cerebro Placental Ratio		
Ductusvenosus Doppler		

Signature of Candidate **Signature of Supervisor**

Sr. No	Name	Age	Age group	MRD number	Residential address	Education	Occupation	Obs formula	Booked	Menstrual history	LMP date	LMP POG	EDOD	Risk factor of developing FGR Fetal causes	Maternal cause HTN	Others	DM2	Period of gestation at the time of delivery	Mode of delivery
1	RK	22	1	1119944	Urban	Undergraduate	Housewife	Primi	Outside	Regular	11-12-2020	32	8-9-2021					33.4	Vaginal
2	JG	24	1	1211946	Urban	Graduate	Housewife	Primi	Dmch	Regular	23-4-2021	30	30-1-2022		HTN			30.4	Cesarean
3	SA	28	2	1665146	Urban	Graduate	Housewife	Primi	Outside	Regular	21-4-2021	32.2	28-1-2022		HTN			32.2	Cesarean
4	PK	26	2	1127630	Urban	Graduate	Employed	Primi	Outside	Regular	2-4-2021	37.6	9-1-2022					38.2	Vaginal
5	NK	28	2	1110766	Urban	Postgraduate	Employed	Primi	Dmch	Regular	10-3-2021	37.2	7-12-2021				GDMA2	37.3	Cesarean
6	KK	45	3	1232770	Urban	Undergraduate	Employed	Primi	Dmch	Irregular	9-5-2021	33	16-2-2022		HTN			33.1	Cesarean
7	KA	26	2	1380030	Urban	Graduate	Housewife	Primi	Outside	Regular	22-12-2021	38	29-9-2022					38	Cesarean
8	B	27	2	1259245	Rural	Undergrad	Housewife	Primi	Dmch	Regular	29-12-21	37.3	5-10-22					37.3	Vaginal
9	Kk	26	2	1338703	Urban	Graduate	Employed	Multi	Dmch	Regular	19-4-2021	32.4	26-1-2022		HTN			34	Cesarean
10	PA	27	2	1338501	Urban	Graduate	Employed	Multi	Outside	Regular	16-4-2021	33	23-1-2022		HTN			33	Cesarean
11	MK	28	2	111697	Urban	Postgradua	Employed	Multi	Dmch	Regular	25-7-2021	35.4	6-3-22					36.1	Vaginal
12	HK	29	2	1395190	Urban	Graduate	Employed	Primi	Outside	Regular	7-3-22	31	12-12-2022		HTN			31.1	Vaginal
13	BK	28	2	1259093	Urban	Graduate	Housewife	Primi	Dmch	Regular	24-11-2021	34.2	15-8-22					34.2	Cesarean
14	SK	34	3	430031	Rural	Postgradua	Employed	Multi	Dmch	Regular	3-2-22	34	10-11-22					34	Vaginal
15	RK	37	3	487612	Urban	Undergraduate	Employed	Primi	Dmch	Regular	7-3-22	30.2	12-12-2022		HTN			31	Cesarean
16	RA	26	2	1330255	Urban	Graduate	Employed	Primi	Outside	Regular	13-12-2021	40	19-9-2022					40	Vaginal
17	SK	29	2	1219680	Rural	Undergraduate	Housewife	Multi	Dmch	Regular	23-7-2021	38	4-3-2022		HTN			38.3	Cesarean
18	SA	24	1	1368985	Urban	Graduate	Housewife	Primi	Dmch	Regular	24-12-2022	35.3	30-9-2022		HTN			35.4	Cesarean
19	MA	28	2	1467218	Urban	Postgradua	Employed	Multi	Dmch	Regular	2-10-2021	35.6	9-7-2022					35.6	Cesarean
20	TA	24	1	1288287	Urban	Graduate	Housewife	Primi	Dmch	Regular	14-7-2021	39.2	20-4-2022		HTN			39.2	Vaginal
21	AM	26	2	1146250	Urban	Graduate	Employed	Primi	Outside	Regular	15-12-2020	32.2	22-9-2021		HTN		GDMA1	32.4	Cesarean
22	SN	25	1	1285369	Rural	Undergrad	Housewife	Primi	Dmch	Regular	16-7-2021	38	22-4-2022					38.1	Vaginal
23	RA	32	3	1330255	Urban	Graduate	Employed	Multi	Dmch	Regular	15-12-2021	40	21-9-2022					40	Vaginal
24	MK	25	1	1248592	Urban	Graduate	Employed	Primi	Dmch	Regular	24-7-2021	36	6-3-22					36.1	Cesarean
25	SG	26	2	1272453	Urban	Postgradua	Employed	Primi	Outside	Regular	3-7-2021	37	10-4-2022		HTN			37	Cesarean
26	KK	26	2	1232811	Rural	Graduate	Housewife	Multi	Outside	Regular	4-8-2021	33	11-5-2022		HTN			33	Cesarean

Indication of caesarean	Gestation	Birth weight(kg)	Sex of baby	APGAR SCORE AT 1 MINS	APGAR SCORE AT 5 MINS	Admission to NICU	Prematurity	ABN Doppler	Increased rates of breathing	SGA	Perinatal comp	NEONATAL HYPERBILIRUBINEMIA	NEC	Discharging gestation	Discharging weight (kg)	Neonatal death	P/A : Fundal height	AC
	Preterm	1.64	Male	8	9	Yes	Prematurity			SGA							Yes	32.1
Fetal distress	Preterm	0.87	Female	8	9	Yes	Prematurity			SGA	Mild RDS	Present	NEC I			After one month	No	27
ABN Doppler Msl dec FM	Preterm	0.775	Female	6	8	Yes	Prematurity			SGA	Mild RDS	Present	NEC I	37.3	1.05		Yes	30.2
	Term	2.26	Female	8	9	No				SGA							Yes	33
Fetal distress	Term	2.64	Female	8	6	No				AGA							Yes	32.3
Fetal distress	Preterm	1.38	Male	7	8	Yes	Prematurity	ABN Doppler		SGA	Mild RDS	Present	NEC I			After 15 days	Lag	30.4
Anhydramnios with FD	Term	1.59	Male	7	8	Yes				SGA	Severe RDS			38.3	1.72		Yes	33.4
	Term	2.15	Female	8	9	No				SGA							Yes	35.3
ABN Doppler with FD	Preterm	1.12	Male	8	9	Yes	Prematurity			SGA	Mild RDS			36.5	1.75		Lag	29.4
ABN Doppler with FD	Preterm	1.38	Male	7	6	Yes	Prematurity			SGA	Mild RDS	Present	NEC I	36.4	1.64		Lag	30
	Preterm	2.62	Male	8	9	No				AGA				36.5	2.85		Yes	34.6
	Preterm	1.5	Female	8	9	Yes	Prematurity	ABN Doppler		AGA	Mild RDS		NEC I	33	1.64		Yes	29.6
Fetal distress	Preterm	2	Female	8	10	No				AGA							Yes	32.4
	Preterm	2.1	Male	8	10	No				AGA							Yes	32.6
Fetal Distress	Preterm	1.23	Female	7	8	Yes	Prematurity	ABN Doppler	Present	SGA	Severe RDS			35	1.88		Lag	27.5
	Term	2.5	Male	8	9	No				SGA							Yes	37.1
MSL,ST,PPROM	Term	2.51	Female	8	9	Yes		ABN Doppler		SGA				37.5	2.48		Yes	33.2
Impending eclampsia	Preterm	2.26	Male	8	9	No				AGA							Yes	34.2
Fetal distress	Preterm	2.32	Female	8	9	No				AGA							Yes	33.4
	Term	2.86	Female	8	9	No				AGA							Yes	37.2
Fetal distress	Preterm	1.56	Male	7	6	Yes	Prematurity	ABN Doppler	Present	SGA	Mild RDS			34.2	1.83		Yes	33
	Term	2.53	Female	8	9	No				SGA							Yes	36.4
	Term	3.12	Male	8	9	No				AGA							Yes	37.4
Fetal distress	Preterm	2.56	Male	8	9	No				AGA							Yes	35.2
MSL with FD	Term	2.45	Male	9	10	No				SGA							Yes	36.5
Brain sparing dec FM	Preterm	1.38	Male	7	6	Yes	Prematurity	ABN Doppler		SGA	Mild RDS	Present	NEC I	36	1.53		Lag	29.6

26-28 weeks_Uterine Artery PI	26-28 weeks_Umbilical Artery S/D	26-28 weeks_Umbilical Artery PI	26-28 weeks_Middle Cerebral Artery PI	28-32 weeks_Uterine Artery PI	28-32 weeks_Umbilical Artery S/D	28-32 weeks_Umbilical Artery PI	28-32 weeks_Middle Cerebral Artery PI	32-36 weeks_Uterine Artery PI	32-36 weeks_Umbilical Artery S/D	32-36 weeks_Umbilical Artery PI	32-36 weeks_Middle Cerebral Artery PI	EFW (kg)	CPR 26-28	CPR 28-32	CPR 32-36	26-28weeks DV	28-32weeks DV	32-36weeks DV
1.005	2.7	1.05	1.84	1.01	2.75	1	1.9	0.7	2.44	0.81	1.95	1.66	1.8	1.9	2.4			
1.28	3	1.2	2	1.11	AEDF 4.1	1.29	1.9	DEL				0.75	1.7	1.5			Normal	
1.29	3.01	1.2	2.11	1.11	REDF 7.6	REDF	2.12	DEL				0.8	1.8	1.8				
1.24	3	0.89	2.22	1.06	2.67	1.1	2.32	1.13	2.51	0.87	1.93	2.02	2.5	2.1	2.2	Normal	Normal	Normal
1.26	3.02	0.87	2.06	0.84	2.64	1.14	2.06	0.84	2.51	0.94	1.77	2.56	2.4	1.8	1.9	Normal	Normal	Normal
1.35	3.3	1.34	2.33	1.11	3.51	1.3	1.97	1.14	4.4	1.18	1.52	1	1.7	1.5	1.3			
1.27	3	1	1.96	0.84	2.64	1.13	2.3	1.11	2.45	0.91	1.93	1.34	2.0	2.0	2.1	Normal	Normal	Normal
1.24	3	1.19	2.32	0.94	2.75	1.12	2.45	1.11	2.34	0.89	1.94	1.55	1.9	2.2	2.2			
1.31	3.45	1.11	2.23	0.89	4.21	1.32	1.97	DEL				2.24	2.0	1.5				
1.32	3.01	1.2	1.92	0.7	AEDF	1.20	1.94	DEL				1	1.6	1.6				
1.33	2.99	1.35	2.27	1.13	3.55	1.11	1.96	1.15	3.6	1.27	1.52	1.26	1.7	1.8	1.2			
1.24	2.95	1.37	2.02	0.88	3.88	1.20	1.4	DEL				2.54	1.5	1.2				
1.31	2.99	1	1.98	0.96	2.75	1.1	1.98	0.78	2.44	0.89	1.78	1.44	2.0	1.8	2.0			
1.22	2.98	1	2.01	0.84	2.52	1.11	2	1.035	2.32	0.89	1.89	2.7	2.0	1.8	2.1			
1.33	3.02	0.95	1.99	0.69	4.24	1.09	2.39	DEL				1.32	2.1	2.2				
1.24	3.01	1.2	1.94	0.98	3.25	1.33	2.01	1.11	2.9	1.03	1.47	2.44	1.6	1.5	1.4	Normal	Normal	Normal
1.23	2.97	1.2	2.11	1.3	3.24	1.12	1.95	1.07	3.07	1.07	1.47	2.32	1.8	1.7	1.4			Normal
1.33	3	1	2.01	1.07	3.44	1.34	1.94	1.08	4.56	1.1	1.42	2.22	2.0	1.4	1.3			
1.25	2.97	0.99	2.04	0.98	2.64	1.13	1.92	0.88	2.44	0.91	1.88	2.48	2.1	1.7	2.1			
1.31	2.89	1.2	1.93	0.87	2.56	1.07	2.02	1.04	2.53	0.95	1.75	2.71	1.6	1.9	1.8			
1.34	3.02	0.97	2.12	0.76	2.94	1.22	1.93	1.1	AEDF	1.36	1.45	1.68	2.2	1.6	1.1		Normal	
0.76	3	1	2.01	1.02	2.51	0.95	1.92	1.15	2.47	1.03	1.87	2.45	2.0	2.0	1.8			
1.24	2.98	0.88	1.92	0.96	2.76	1.06	1.8	0.78	2.45	0.98	1.89	3.21	2.2	1.7	1.9			
1.19	2.89	0.89	2.13	1.07	2.76	1.14	1.88	1.16	2.12	0.96	1.79	2.44	2.4	1.6	1.9			
1.31	3.01	1.2	2.01	0.77	2.74	1.13	1.94	0.68	2.52	0.97	1.8	2.36	1.7	1.7	1.9	Normal	Normal	Normal
1.32	3.44	1.2	1.92	1.04	2.98	1.05	1.85	1.1	5.2	0.89	1.42	1.23	1.6	1.8	1.6			

27	Sk	24	1	1217682	Urban	Graduate	Housewife	Primi	Outside	Irregular	21-4-2021	32.2	28-1-2022		HTN			32.2	Cesarean
28	RA	30	2	1149043	Urban	Postgradua	Employed	Multi	Dmch	Regular	21-12-2022	35	27-9-2022				GDMA1	35.5	Cesarean
29	SK	27	2	991695	Urban	Graduate	Employed	Primi	Dmch	Regular	1-3-2020	38	6-12-2020				GDMA1	38.3	Vaginal
30	RK	28	2	1218063	Urban	Undergrad	Housewife	Multi	Dmch	Regular	19-4-2021	32.2	26-1-2022					32.2	Cesarean
31	KA	25	1	1245850	Urban	Graduate	Employed	Primi	Outside	Regular	25-2-2021	37.6	4-12-2021					38.1	Cesarean
32	KB	28	2	1240674	Urban	Postgradua	Employed	Multi	Dmch	Regular	23-2-2021	35	2-12-2021					35	Vaginal
33	YJ	26	2	1243553	Urban	Graduate	Housewife	Primi	Dmch	Regular	17-4-2021	33	24-1-2022		HTN			35	Cesarean
34	PK	23	1	1237362	Urban	Graduate	Housewife	Primi	Dmch	Regular	3-3-2020	34	8-12-2020		HTN			34	Cesarean
35	DA	31	3	1180277	Urban	Graduate	Employed	Multi	Outside	Regular	8-3-2022	37.4	13-12-2022			PROM		38.4	Vaginal
36	AG	26	2	1227058	Urban	Undergrad	Housewife	Primi	Dmch	Regular	30-1-2021	36	6-10-2021					37	Vaginal
37	FC	32	3	1200976	Urban	Postgradua te	Employed	Multi	Dmch	Regular	29-3-2021	29.6	4-1-22		HTN			31	Cesarean
38	RK	34	3	1401486	Urban	Graduate	Housewife	Primi	Outside	Regular	29-1-2022	37.6	5-11-2022		HTN			38	Cesarean
39	BA	27	2	1259245	Urban	Graduate	Housewife	Primi	Dmch	Regular	29-12-2021	37	5-10-2022		HTN	Prom		37.2	Cesarean
40	BR	33	3	1042214	Urban	Graduate	Housewife	Multi	Dmch	Regular	20-4-2020	27	27-1-2021		HTN	Overt Hypothyroid		27	Cesarean
41	JK	31	3	1127172	Urban	Undergrad uate	Housewife	Primi	Outside	Regular	15-12-2020	27	22-9-2021		HTN	Overt Hypothyroid		28	Vaginal
42	Jk	22	1	1141268	Rural	Graduate	Employed	Primi	Dmch	Regular	14-1-2021	31	21-10-2021					32	Cesarean
43	PJ	27	2	1184515	Urban	Graduate	Housewife	Primi	Dmch	Regular	5-3-2022	38.4	10-12-2022			Prom		38.5	Vaginal
44	HK	29	2	789613	Rural	Undergrad	Housewife	Primi	Outside	Regular	4-3-2021	35	9-12-2021			Ptlp		35.5	Vaginal
45	TR	33	3	953391	Urban	Graduate	Employed	Multi	Dmch	Regular	11-3-2021	36	18-12-2021				GDMA1	36.6	Cesarean
46	AB	32	3	1267891	Urban	Graduate	Housewife	Primi	Outside	Regular	25-5-2021	27	3-1-2022	SUA	HTN		Overt	27.1	Cesarean
47	MD	36	3	1218270	Urban	Postgradua	Employed	Primi	Outside	Irregular	17-5-2021	35	28-2-2022		HTN			35.1	Cesarean
48	KA	27	2	1245564	Urban	Graduate	Housewife	Primi	Outside	Regular	9-5-2021	33	13-2-2022		HTN			33.1	Cesarean
49	MK	28	2	1191784	Rural	Undergrad	Housewife	Primi	Outside	Irregular	27-5-2021	29.6	3-3-2022		HTN			30	Cesarean
50	HK	32	3	1244425	Urban	Graduate	Housewife	Multi	Dmch	Regular	5-5-2021	37.5	9-2-2022					37.6	Vaginal
51	PK	32	3	1251295	Urban	Undergrad	Housewife	Primi	Outside	Irregular	6-5-2021	30.6	10-2-2022		HTN			31.2	Cesarean
52	NK	23	1	1248350	Rural	Graduate	Housewife	Primi	Outside	Regular	22-7-2021	32.2	29-3-2022					32.3	Cesarean
53	PA	33	3	1248919	Urban	Undergrad	Housewife	Primi	Outside	Irregular	16-7-2021	28.6	22-4-2022		HTN	SLE		29	Cesarean
54	PK	32	3	818572	Rural	Graduate	Housewife	Multi	Outside	Irregular	24-6-2021	33	31-3-2022		HTN			33	Cesarean
55	JK	28	2	1255105	Urban	Postgradua	Employed	Primi	Outside	Regular	4-7-2021	28	1-4-2022		HTN			28	Cesarean
56	DG	31	3	1152368	Urban	Postgradua	Employed	Multi	Dmch	Regular	19-6-2021	32	26-3-2022					32.4	Vaginal
57	SG	25	1	1270663	Urban	Graduate	Employed	Primi	Dmch	Regular	3-7-2021	34	10-4-2022			Ptlp		34.2	Vaginal
58	RK	26	2	1277021	Urban	Undergrad	Housewife	Primi	Dmch	Regular	17-7-2021	36	24-4-2022		HTN			36.1	Cesarean
59	BA	25	1	1282322	Urban	Graduate	Employed	Multi	Outside	Regular	22-7-2021	36	29-4-22			Ptlp		36.5	Vaginal

ABN Doppler with FD	Preterm	0.775	Female	6	8	Yes	Prematurity	ABN Doppler		SGA	Severe RDS	Present	NEC I	37.3	1.05		Lag	29.6
Fetal distress	Preterm	2.35	Male	8	10	No				AGA							Yes	34.3
	Term	2.62	Female	8	9	No				SGA							Yes	37.2
Fetal distress	Preterm	1.44	Male	6	6	Yes	Prematurity	ABN Doppler		SGA	Mild RDS	Present	NEC I	36	1.36		Yes	30.1
Fetal distress	Term	2.24	Male	8	9	No				SGA							Lag	34.2
	Preterm	1.98	Female	8	9	No				SGA							Yes	33.6
Fetal distress	Preterm	1.46	Female	8	9	Yes	Prematurity			SGA	Mild RDS			36.1	1.5		Yes	30.4
MSL with FD	Preterm	1.72	Male	7	6	Yes	Prematurity	ABN Doppler		SGA	Severe RDS	Present	NEC I	37.1	1.81		Yes	32.2
	Term	2.72	Male	8	9	No				AGA							Yes	36.6
	Term	2.34	Male	8	9	No				SGA							Yes	33.4
ABN Doppler with FD	Preterm	1.08	Female	7	8	Yes	Prematurity	ABN Doppler	Present	SGA	Moderate RD	Present	NEC IIB	34.3	1.24		Lag	27.4
Fetal distress	Term	2.62	Male	8	9	No				AGA							Yes	36.6
Fetal distress	Term	1.96	Female	8	9	Yes		ABN Doppler		SGA				38	1.89		Yes	35.4
Eclampsia	Preterm	0.85	Male	6	6	Yes	Prematurity			AGA	Severe RDS		NEC I	34	1.41		Yes	26.5
	Preterm	0.97	Male	7	8	Yes	Prematurity	ABN Doppler		SGA		Present		33	1.18		Yes	26.6
Fetal distress	Preterm	1.32	Female	8	9	Yes	Prematurity	ABN Doppler		SGA	Mild RDS			34.6	1.52		Lag	31.4
	Term	2.6	Female	8	9	No				AGA							Yes	36.5
	Preterm	2.64	Male	8	9	No				AGA							Yes	34.2
Scar tenderness	Preterm	2.32	Male	8	9	No				AGA							Yes	35.5
AEDF with fetal distress	Preterm	0.86	Male	7	6	Yes	Prematurity	ABN Doppler	Present	AGA	Moderate RDS		NEC I			After 21	Lag	25.4
Impending eclampsia	Preterm	1.74	Female	7	9	Yes	Prematurity	ABN Doppler		SGA	Mild RDS			36.5	2.1		Lag	30.6
Eclampsia	Preterm	1.56	Female	6	8	Yes	Prematurity			SGA	Moderate RD	Present		35	2		Yes	30.2
Primi with breech in labour	Preterm	1.12	Male	8	9	Yes	Prematurity	ABN Doppler		SGA	Mild RDS	Present		35.6	1.45		Lag	27.5
	Term	2.63	Female	8	9	No				AGA							Yes	36.6
MSL with FD	Preterm	1.26	Male	8	9	Yes	Prematurity			SGA	Moderate RD	Present		34	1.67		Yes	30.4
Fetal distress	Preterm	1.7	Male	8	9	Yes	Prematurity			AGA							Yes	31.1
Impending eclampsia	Preterm	0.98	Male	7	9	Yes	Prematurity	ABN Doppler		SGA	Moderate RDS					After one	Lag	26.3
Reversal in DV with fetal distress	Preterm	1.64	Male	6	6	Yes	Prematurity	ABN Doppler		SGA	Severe RDS	Present	NEC I			After 3days	Lag	29.6
ABN Doppler with FD	Preterm	0.86	Female	7	10	Yes	Prematurity	ABN Doppler		SGA	Severe RDS	Present		34	1.74		Lag	27.5
	Preterm	1.64	Male	8	9	Yes	Prematurity			AGA				34	1.72		Yes	31.4
	Preterm	2.14	Male	8	9	No				AGA							Yes	32.2
MSL with FD	Preterm	2.32	Female	8	9	No				AGA							Lag	31.6
	Preterm	2.35	Male	8	9	No				AGA							Yes	35.4

1.33	2.98	0.85	1.92	1.11	2.75	1.11	1.9	1.24	4.52	0.89	1.79	0.64	2.3	1.7	2.0			
1.3	2.97	0.92	1.95	1.04	2.62	0.97	1.95	0.71	2.22	0.84	1.84	2.26	2.1	2.0	2.2			
0.95	3.03	1.2	1.96	0.93	2.68	1.1	1.89	1.14	2.44	0.8	1.75	2.52	1.6	1.7	2.2	Normal	Normal	Normal
1.28	3.04	1.28	1.89	1.18	2.74	1.04	1.88	1.17	REDF	1.11	1.68	1.36	1.5	1.8	1.5			
1.32	3.45	1.11	1.89	1.2	2.8	1.14	1.95	1.19	2.84	1.04	1.48	2.11	1.7	1.7	1.4			
1.24	2.98	1.12	1.9	1.05	2.67	0.99	1.85	1.08	2.44	0.86	1.7	1.87	1.7	1.9	2.0	Normal	Normal	Normal
1.44	3.02	1.42	2.04	0.99	2.54	0.92	1.87	0.77	2.47	0.98	1.22	1.35	1.4	2.0	1.2			
1.38	3.94	1.2	1.94	1.34	5.2	0.81	1.84	1.18	5.7	1.2	1.44	1.82	1.6	2.3	1.2			
0.92	3	1.04	2.22	0.88	2.64	1.03	2.28	1.12	2.22	0.81	1.8	2.77	2.1	2.2	2.2			
1.29	2.89	0.89	1.98	0.77	2.75	1.12	1.89	1.05	2.21	0.89	1.82	2.36	2.2	1.7	2.0	Normal	Normal	Normal
1.68	2.99	1.13	1.88	0.98	REDF	1.55	1.04	DEL				1	1.7	0.7				
1.22	3.01	0.9	1.92	0.97	2.65	1.2	1.89	0.56	2.69	0.97	1.1	2.54	2.1	1.6	1.1			
0.99	3.03	0.87	1.86	0.77	2.66	1.14	1.84	1.06	2.88	1.09	1.53	1.87	2.1	1.6	1.4			
1.3	5.5	1.5	1.6	DEL				DEL				0.86	1.1					
2.15	AEDF	0.98	1.8	DEL				DEL				0.75	1.8					
1.44	3.88	1.04	1.86	1.74	3.4	1.15	1.21	DEL				1.21	1.8	1.1				
1.24	2.99	1	1.84	0.87	2.67	0.83	1.87	1.05	2.44	0.82	1.7	2.54	1.8	2.3	2.1	Normal	Normal	Normal
1.22	2.86	1.2	1.89	0.79	2.56	1.02	1.82	0.77	2.45	0.97	1.72	2.77	1.6	1.8	1.8	Normal	Normal	Normal
0.99	3	1.11	1.87	0.85	2.68	1.1	1.84	1.16	2.47	0.72	1.66	2.23	1.7	1.7	2.3			
1.34	AEDF	1.34	1.67	DEL				DEL				0.98	1.2					
1.31	3.28	1.22	1.85	1.42	3.65	1.02	1.78	0.54	REDF 3.26	4.33	1.02	1.72	1.5	1.7	0.2			
1.24	2.97	1.2	1.89	0.85	2.65	0.89	1.82	0.78	2.52	1.02	1.78	1.45	1.6	2.0	1.7			
1.36	2.96	0.98	1.82	1.03	7.5	0.97	1.28	DEL				1.16	1.9	1.3				
0.89	2.75	0.88	2.21	0.97	2.69	1.12	1.86	0.6	2.45	0.9	1.6	2.65	2.5	1.7	1.8			
1.22	2.66	1.11	1.88	0.95	2.5	0.96	1.9	DEL				1.23	1.7	2.0				
0.9	3	0.89	1.87	0.76	2.44	0.96	1.99	DEL				1.88	2.1	2.1				
1.48	AEDF	1.42	1.76	DEL				DEL				0.86	1.2					
1.33	3	1.2	2.21	1.04	2.64	1.22	1.89	1.13	REDF	5.8	1.2	1.63	1.8	1.5	0.2			
1.24	AEDF	2.32	1.2	DEL				DEL				0.87	0.5					
0.63	2.45	0.85	1.84	0.6	1.81	0.6	1.88	DEL				1.68	2.2	3.1		Normal	Normal	
1.29	2.94	0.9	1.89	0.75	2.48	0.95	1.84	1.04	2.48	1	1.68	2.11	2.1	1.9	1.7			
1.27	3.05	1.07	1.89	0.98	2.55	0.86	1.92	0.65	2.23	1.02	1.87	2.22	1.8	2.2	1.8	Normal	Normal	
1.28	2.55	1.11	1.84	1	2.65	1.03	1.87	0.99	2.51	0.77	1.54	2.54	1.7	1.8	2.0			

60	HS	38	3	1292338	Urban	Postgradua	Employed	Multi	Outside	Regular	8-9-2021	31.6	15-6-2022					32.6	Cesarean
61	RR	34	3	1267858	Rural	Graduate	Housewife	Primi	Outside	Regular	30-9-2021	32.4	7-7-2022		HTN			32.6	Vaginal
62	MA	32	3	1216242	Urban	Graduate	Employed	Multi	Outside	Regular	2-10-2021	32	9-7-2022			Ptlp		32	Vaginal
63	MS	22	1	1268491	Urban	Undergrad	Housewife	Primi	Dmch	Regular	29-9-2021	35.4	6-7-2021		HTN			36	Cesarean
64	MA	39	3	1156596	Rural	Graduate	Employed	Multi	Dmch	Regular	17-3-2021	30	24-12-2021			Ptlp PPROM		31	Vaginal
65	CD	28	2	1462481	Urban	Postgradua	Employed	Primi	Dmch	Regular	13-4-2021	38	20-1-2022					38	Vaginal
66	PG	27	2	1658214	Rural	Graduate	Employed	Primi	Dmch	Regular	29-3-2021	31.5	5-1-2022					31.6	Cesarean
67	AS	26	2	1745211	Urban	Graduate	Housewife	Primi	Dmch	Regular	17-4-2021	27.4	22-1-2022		HTN			27.5	Cesarean
68	KK	25	1	995236	Rural	Graduate	Employed	Multi	Dmch	Regular	4-3-2022	28.4	11-12-2022			Ptlp		35.6	Cesarean
69	HG	27	2	1379941	Urban	Postgradua te	Employed	Multi	Dmch	Regular	7-5-2021	31.2	11-2-2022		HTN			32	Cesarean
70	RA	25	1	1382215	Urban	Graduate	Employed	Primi	Outside	Regular	2-2-2022	32.5	13-11-2022			Ptlp		32.6	Vaginal
71	SG	26	2	1462284	Urban	Graduate	Employed	Primi	Outside	Regular	2-3-2022	27.2	7-12-2022		HTN			27.3	Cesarean
72	MA	25	1	1364835	Urban	Graduate	Employed	Primi	Dmch	Regular	2-5-2022	28.6	6-2-2023					29	Cesarean
73	CS	32	3	1418533	Urban	Graduate	Housewife	Multi	Outside	Regular	22-4-2022	30.3	29-1-2023		HTN			30.4	Cesarean
74	SK	27	2	1410282	Urban	Undergrad uate	Housewife	Primi	Dmch	Regular	4-3-2022	37.4	11-12-2023			Decreased fetal movements		37.5	Cesarean
75	JK	24	1	1426858	Rural	Graduate	Employed	Multi	Dmch	Regular	25-11-2021	35	1-9-2022			Ptlp		35.6	Vaginal
76	Kk	24	1	1324618	Urban	Graduate	Employed	Primi	Dmch	Regular	7-6-2021	36	11-3-2022		HTN			37	Vaginal
77	SK	36	3	1409583	Urban	Graduate	Housewife	Primi	Outside	Regular	5-4-2022	30.4	12-1-2023		HTN			32.1	Cesarean
78	PA	28	2	1462814	Urban	Postgradua te	Employed	Multi	Dmch	Regular	25-5-2021	29	25-2-2022			Maternal Heart Disease		30	Vaginal
79	RK	26	2	1326589	Urban	Graduate	Employed	Primi	Dmch	Regular	28-5-2021	38	4-3-2022			Latent labour		38.2	Vaginal
80	KK	35	3	1368859	Rural	Graduate	Employed	Primi	Outside	Regular	27-6-2021	37.3	3-4-2022					37.5	Vaginal
81	RA	28	2	1258963	Urban	Graduate	Employed	Primi	Dmch	Regular	22-6-2021	35	29-3-2022		HTN			35.4	Cesarean
82	PA	30	2	1374212	Urban	Postgradua	Employed	Multi	Dmch	Regular	1-7-2021	37.3	7-4-2022					37.5	Vaginal
83	MK	29	2	1258964	Rural	Undergrad	Housewife	Multi	Outside	Regular	10-5-2021	30.1	14-2-2022		HTN	Ptlp PPROM		32	Vaginal
84	GA	34	3	1425678	Urban	Graduate	Housewife	Multi	Outside	Regular	2-5-2021	36.3	6-2-2022					37	Cesarean
85	KA	22	1	1159632	Rural	Undergrad	Housewife	Primi	Outside	Irregular	3-5-2021	31.4	7-2-2022			CMV-IgM +		31.5	Vaginal
86	GK	30	2	1462128	Urban	Graduate	Employed	Multi	Outside	Regular	7-5-2021	32.3	11-2-2022		HTN			32.4	Cesarean
87	RK	29	2	1145263	Urban	Postgradua te	Employed	Primi	Outside	Regular	6-5-2021	35.2	10-2-2022			Placenta pre via		36	Cesarean
88	HK	35	3	1684523	Urban	Graduate	Employed	Multi	Outside	Regular	7-4-2021	29	14-1-2022		HTN	SLE		29	Cesarean

Fetal distress	Preterm	1.64	Female	6	6	Yes	Prematurity			AGA				34.5	1.8		Lag	29.6
	Preterm	1.68	Male	7	8	Yes	Prematurity			AGA				35	1.84		Yes	30.5
	Preterm	2.06	Male	8	9	No				AGA							Yes	31.4
Scar tenderness	Preterm	2.35	Male	7	10	Yes				AGA				36.5	2.25		Yes	31.6
	Preterm	0.98	Male	8	9	Yes	Prematurity	ABN Doppler		SGA				35	1.78		Yes	27.1
	Term	2.66	Female	8	9	No				AGA							Yes	36.4
MSL with FD	Preterm	1.68	Male	8	9	Yes	Prematurity			AGA				34.6	1.89		Yes	28.6
Eclampsia	Preterm	0.85	Male	7	10	Yes	Prematurity	ABN Doppler		AGA				34	1.42		Yes	26.6
Scar tenderness	Preterm	2.3	Female	8	10	No				AGA							Yes	34.2
ABN Doppler with FD	Preterm	1.25	Male	8	9	Yes	Prematurity	ABN Doppler		SGA				34.6	1.56		Yes	29.6
	Preterm	1.42	Female	8	9	No				SGA							Lag	31.2
REDF with FD	Preterm	0.84	Male	7	8	Yes	Prematurity	ABN Doppler		SGA	Severe RDS	Present				After 8 days	Lag	23.2
AEDF with fetal distress	Preterm	1.02	Male	5	7	Yes	Prematurity	ABN Doppler		SGA	Severe RDS		NEC I	34	1.45		Yes	25.2
Fetal distress	Preterm	1.1	Male	5	7	Yes	Prematurity	ABN Doppler		SGA	Mild RDS			33.6	1.64		Yes	29.6
REDF with FD	Term	2.52	Male	9	10	Yes		ABN Doppler		AGA				38	2.69		Yes	36.6
	Preterm	2.1	Female	8	9	No				AGA							Yes	34.2
	Term	2.34	Female	8	9	No				SGA							Yes	33
Fetal distress	Preterm	1.03	Male	7	9	Yes	Prematurity	ABN Doppler		SGA	Severe RDS			35	1.65		Yes	27.2
	Preterm	0.985	Female	8	9	Yes	Prematurity			AGA	Moderate RDS					After 1 month	Yes	28.6
	Term	2.62	Female	8	9	No				AGA							Yes	36.6
	Term	2.7	Male	8	10	No				AGA							Lag	36.6
MSL with FD	Preterm	1.88	Female	8	9	Yes	Prematurity			SGA				36.1	2.5		Yes	31.2
	Term	2.34	Male	8	9	Yes		ABN Doppler		SGA				38	2.42		Yes	35.3
	Preterm	0.98	Female	8	9	Yes	Prematurity	ABN Doppler		SGA				34.1	1.52		Yes	27.6
Scar tenderness	Term	1.78	Female	8	10	Yes		ABN Doppler		SGA				37.6	1.86		Yes	36.3
	Preterm	1.33	Male	8	10	Yes	Prematurity	ABN Doppler		SGA				34.5	2.45		Yes	29.2
Decreased FM with FD	Preterm	1.26	Female	7	9	Yes	Prematurity	ABN Doppler		SGA	Mild RDS			35.1	1.89		Yes	31.3
Placenta pre via type 4 in labor with APH	Preterm	1.91	Male	8	10	No				SGA				36.3	2.32		Yes	31.2
Eclampsia	Preterm	0.85	Female	5	7	Yes	Prematurity	ABN Doppler		SGA	Severe RDS					After 20 days	Yes	28.6

1.28	AEDF	0.88	1.85	1.03	2.64	1.1	1.89	DEL				1.6	2.1	1.7				
0.84	3.04	0.94	1.98	0.99	2.76	1.11	2.21	DEL				1.67	2.1	2.0				
1.26	3	1.2	2.21	0.68	2.55	1.06	1.88	DEL				2.01	1.8	1.8				
0.99	2.75	0.87	2.2	0.77	2.69	1.14	1.86	0.88	2.52	0.76	1.92	2.32	2.5	1.6	2.5			
1.34	2.89	0.98	2.22	0.59	2.68	0.74	1.82	DEL				0.95	2.3	2.5				
0.84	2.99	1.05	1.98	0.78	2.89	1.2	1.2	1	3.04	1.1	1.44	2.55	1.9	1.0	1.3			
1.46	3.03	1.14	1.87	0.65	2.8	1.01	2	DEL				1.68	1.6	2.0				
1.95	REDF	1.44	1.74	DEL				DEL				0.84	1.2					
1.32	3.72	1.2	1.87	0.68	2.64	1.15	1.87	1.11	4.24	1.14	1.48	2.22	1.6	1.6	1.3			
1.3	3.04	1.3	1.85	0.64	3.9	1.3	2.2	DEL				1.26	1.4	1.7				
1.44	3.46	0.96	1.84	0.8	2.44	1.32	1.76	DEL				1.32	1.9	1.3				
0.8	REDF	1.54	2.9	DEL				DEL				0.83	1.9					
1.22	REDF	2.28	2.41	DEL				DEL				1	1.1					
1.32	3.44	0.95	1.86	0.7	5	1.88	1.41	DEL				1.23	2.0	0.8				
1.2	3.48	1.22	2	0.66	2.88	1.28	1.66	0.78	2.97	1.07	1.34	2.5	1.6	1.3	1.3	Normal	Normal	Normal
1.21	3.54	1.06	1.82	0.62	2.72	1.34	1.7	0.89	2.88	1.09	1.32	2.11	1.7	1.3	1.2			
1.24	3.02	1.05	1.86	0.82	2.79	1.2	1.86	1.09	2.88	1.11	1.5	2.33	1.8	1.6	1.4			
1.33	2.96	1.2	1.92	0.73	2.12	1	1.31	DEL				1.02	1.6	1.3				
1.28	3.26	1.22	1.82	0.6	2.89	1.16	1.72	DEL				0.96	1.5	1.5				
1.32	3.02	1.34	1.88	0.88	2.68	1.22	1.4	1.12	2.7	1.2	1.44	2.54	1.4	1.1	1.2	Normal	Normal	Normal
1.28	3.01	0.89	1.85	0.72	3.58	1.17	1.6	1.05	4.42	1.13	0.148	2.06	2.1	1.4	0.1			
1.21	3.46	0.98	1.7	0.64	2.46	1.2	1.54	1.03	2.26	1.06	1.68	1.87	1.7	1.3	1.6			
1.28	3.22	1.38	2	0.7	2.78	1.24	1.8	1.11	2.8	1.04	1.33	2.33	1.4	1.5	1.3			
1.27	3.45	1.34	1.84	0.65	2.88	1.26	1.92	DEL				0.94	1.4	1.5				
1.22	3	1.44	1.98	0.74	2.84	1.23	1.96	1.04	2.23	1.15	1.32	1.74	1.4	1.6	1.1			
1.32	3.44	1.38	1.8	0.68	2.99	1.35	1.68	DEL				1.32	1.3	1.2				
1.28	4.28	1.46	2.01	0.8	AEDF	1.18	1.45	DEL				1.25	1.4	1.2		Normal	Normal	
1.3	3.24	1.48	1.95	0.84	3	1.12	1.82	1.02	2.89	1.24	1.22	1.88	1.3	1.6	1.0	Normal	Normal	Normal
1.24	3.36	1.44	2.12	DEL				DEL				0.78	1.5					

89	RA	26	2	1487219	Urban	Graduate	Housewife	Primi	Dmch	Regular	25-4-2021	38	30-1-2022					38.2	Vaginal
90	KD	25	1	1326589	Rural	Undergrad	Housewife	Primi	Dmch	Regular	7-5-2021	36.5	11-2-2022			PPROM		37	Vaginal
91	AA	26	2	1578844	Urban	Postgradua	Employed	Primi	Dmch	Regular	12-9-2021	39	19-6-2022		HTN			39.1	Vaginal
92	HK	29	2	1684595	Urban	Graduate	Employed	Multi	Dmch	Regular	18-10-2021	37.6	25-7-2022			CMV-IgM +		37.6	Cesarean
93	GK	25	1	1134875	Urban	Graduate	Employed	Primi	Dmch	Regular	6-7-2021	31	12-4-2022			PPROM		34	Vaginal
94	BK	29	2	827322	Rural	Graduate	Employed	Multi	Outside	Regular	27-7-2021	37.6	3-4-2022		HTN			38	Cesarean
95	RK	55	3	1421734	Urban	Undergrad uate	Housewife	Primi	Outside	Regular	11-4-2022	32.5	16-1-2023		HTN			33.5	Cesarean
96	PK	34	3	1289412	Urban	Graduate	Employed	Multi	Outside	Regular	3-5-2021	36	7-2-2022					36.1	Vaginal
97	GT	36	3	1326985	Urban	Graduate	Housewife	Primi	Dmch	Regular	25-4-2021	37	30-1-2022					37.6	Cesarean
98	HK	25	1	1586969	Rural	Undergrad uate	Employed	Multi	Outside	Irregular	4-7-2021	29.6	10-4-2022			Maternal Heart Disease		30.2	Vaginal
99	YA	26	2	1463958	Urban	Postgradua	Employed	Primi	Outside	Regular	26-3-2021	39.1	2-1-22		HTN			39.1	Cesarean
100	JT	30	2	1489476	Urban	Graduate	Employed	Primi	Dmch	Regular	3-1-2022	37.2	10-10-2022					37.3	Vaginal

	Term	2.45	Female	8	9	No				SGA				38.4	2.43		Yes	35.2
	Term	2.32	Male	8	10	Yes		ABN Doppler		SGA				36.1	2.64		Lag	32.1
	Term	2.42	Male	8	10	No				SGA				36.3	2.87		Yes	36.4
MSL with FD	Term	2.01	Female	8	9	Yes		ABN Doppler		SGA				38	2.56		Yes	34.3
	Preterm	1.84	Male	7	9	Yes	Prematurity	ABN Doppler		SGA				36	2.44		Yes	33.6
Placenta accreta with APH	Term	2.22	Female	8	9	Yes		ABN Doppler		SGA				38.2	2.72		Yes	33.1
Placenta pre via type 4 in labor with APH	Preterm	1.32	Female	7	9	Yes	Prematurity	ABN Doppler		SGA	Mild RDS			36	1.85		Yes	31.1
	Preterm	2	Female	8	9	Yes	Prematurity			SGA				37	1.78		Yes	33.2
Fetal distress	Term	1.96	Male	8	9	No				SGA				38.2	2.01		Yes	36.4
	Preterm	0.98	Male	7	8	Yes	Prematurity	ABN Doppler		SGA				33.1	1.34		Yes	27.4
Fetal distress	Term	2.35	Female	8	9	No				SGA				39.5	2.45		Yes	36.6
	Term	2.2	Female	8	9	No				SGA				38	2.28		Yes	35.4

1.21	3.44	1.42	1.88	0.65	2.99	1.18	1.94	1.02	2.64	1.13	1.65	2.35	1.3	1.6	1.5			
1.22	3.56	1.3	1.85	0.72	3.44	1.24	1.58	1	4.22	1.23	1.23	2.26	1.4	1.3	1.0			
1.25	3.64	1.44	2.01	0.8	2.88	1.34	1.92	1.11	AEDF	1.88	1.47	2.36	1.4	1.4	0.8			
1.18	2.98	1.02	1.84	0.78	4.52	1.22	1.88	1	4.75	1.64	1.77	2	1.8	1.5	1.1			
1.28	3	1.2	2.2	0.64	2.99	1.24	1.89	DEL				1.89	1.8	1.5				
1.32	3.84	1.4	1.65	0.68	2.82	1.31	1.74	1.07	AEDF	1.3	1.5	2.32	1.2	1.3	1.2	Normal	Normal	Normal
1.24	3.64	0.98	1.88	0.8	5	1.99	1.89	DEL				1.35	1.9	0.9				
1.21	2.97	0.97	2.12	0.66	2.52	1.2	1.68	1.04	2.46	1.32	1.72	1.98	2.2	1.4	1.3			
1.26	3.28	1.36	1.68	0.72	2.89	1.2	1.72	1.06	2.52	1.28	1.7	1.99	1.2	1.4	1.3			
1.24	3.44	1.48	1.66	0.82	2.72	1.36	1.8	DEL				0.96	1.1	1.3				
1.23	2.77	0.98	2.07	0.86	2.84	1.24	1.8	1.11	4.42	1.24	1.22	2.32	2.1	1.5	1.0	Normal	Normal	Normal
1.21	3.36	1.43	1.7	0.64	2.44	1.22	1.64	1.26	2.6	1.27	1.58	2.01	1.2	1.3	1.2	Normal	Normal	Normal

Baba Farid University
of Health Sciences
Sadiq Road
Faridkot-151 203 (Pb). INDIA.
Phone : 01639-256232,256236
Tele/Fax : 01639-256235
Email – Examination@bfuhs.ac.in

(37)

No. BFUHS/2K21p-TH/ 144

Date 05/01/22

The Principal,
DMC, Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.10.2021 has approved the plan of thesis of **Rashim Aneja**, a student of your college for **MD Obstetrics & Gynaecology** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis

Role of color doppler flowmetry in prediction of fetal growth restriction and correlation of doppler parameters with perinatal outcome.

Supervisor

Dr. Suman Puri
Prof. & Head (Unit II), Dept. of Obst. & Gynae.,
DMCH, Ludhiana.

Co-Supervisor

Dr. Kamini Gupta
Prof.,
Dept. of Radio-diagnosis,
DMCH, Ludhiana.

Dr. Pooja Tandon
Assoc. Prof.,
Dept. of Obst. & Gynae.,
DMCH, Ludhiana.

The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

77. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*
78. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED IN

PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MD

In

OBSTETRICS & GYNAECOLOGY

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

MARCH, 2021

DR. RASHIM ANEJA

DEPARTMENT OF OBSTETRICS & GYNAECOLOGY
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME
For the degree of	MD (Obstetrics & Gynaecology)
Name of the candidate	Dr. Rashim Aneja
Supervisor	Dr. Suman Puri, Professor & Head (Unit II), Department of Obstetrics & Gynaecology, DMCH, Ludhiana
Co-supervisor(s)	Dr. Kamini Gupta, Professor, Department of Radiodiagnosis, DMCH, Ludhiana Dr. Pooja Tandon, Associate Professor, Department of Obstetrics & Gynaecology, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: FGR is failure to achieve a specific growth potential which is associated with an increased risk of perinatal mortality and morbidity. The average incidence of FGR is about 8%. FGR is defined as estimated fetal weight <10thpercentile for gestational age. Early detection and timely intervention in FGR babies can help in significantly improving perinatal outcome.

Aim of Study: To evaluate role of Doppler flow parameters in prediction and management of fetal growth restriction in antenatal patients and its correlation with perinatal outcome.

Materials & Methods: A prospective study will be conducted on pregnant women >26 weeks gestation attending antenatal clinic or admitted in department of obstetrics and gynaecology, DMC&H, Ludhiana which is a tertiary care hospital. These patients would be subjected to USG-FWB and Doppler at 26-28 weeks, 28-32 weeks and 32-36 weeks gestation for assessment of fetal well- being and diagnosis of FGR. These pregnant women will be followed upto 7 days after delivery and various parameters indicating fetal outcome will be recorded. This will be a prospective study conducted on 100 pregnant women. The data would be statistically analyzed

Clinical Significance: Doppler study is a quick, non- invasive procedure wherein multiple vessels are subjected to flowmetry analysis. Detection of abnormal vascular resistance patterns helps in identification of pregnancies requiring close fetal monitoring.We aim to carry out a prospective study to evaluate the role of doppler flowmetry in prediction of FGR and correlation of doppler parameters with perinatal outcome.

Keywords: FGR, Doppler, biophysical profile, non- stress test.

(Signature)	(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME"** exist in the Department of Gynaecology, DMC&H, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis is genuine and is collected by the candidate herself under our supervision and guidance.

Supervisor

Dr Suman Puri
Professor & Head (Unit II)
Department of Obstetrics & Gynaecology
DMCH, Ludhiana

Co-Supervisor(s)

Dr. Kamini Gupta
Professor
Department of Radiodiaagnosis
DMCH, Ludhiana

Dr. Pooja Tandon
Associate Professor
Department of Obstetrics & Gynaecology
DMCH, Ludhiana

Head of the Department

Dr. Ashima Taneja
Professor & Head
Department of Obstetrics & Gynaecology
DMCH, Ludhiana

Place : DMCH, Ldh

Date : 7/4/21

APPROVAL PROFORMA
BY
RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr. Rashim Aneja
Department	Obstetrics & Gynaecology
Topic of Thesis	ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME
Likely date of appearing in PG examination	June 2023
Date of enrollment	30th June, 2020
Name of Head of Department	Dr. Ashima Taneja
1) Supervisor **2) Co-Supervisor(s)**	Dr. Suman Puri Dr. Kamini Gupta Dr. Pooja Tandon
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Harpreet Kaur (Professor & Head, Pathology)	Mr. R K Sharma (Legal Expert)
Dr. Jaspal Singh (Professor & Head, Surgery)	Dr. Ramit Mahajan (Associate Professor, Gastroenterology)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)	Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)
Dr. Gurpreet S Wander (Vice Principal)	Dr. Gurpreet S Wander (Vice Principal & Professor & Head, Cardiology)
	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / No

Dr. Sandeep Puri
Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairman
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	Dr. RASHIM ANEJA D3, SUN APARTMENTS, BAREWAL ROAD, LUDHIANA
2	NAME OF THE INSTITUTE	DAYANAND MEDICAL COLLEGE AND HOSPITAL,LUDHIANA
3	COURSE OF STUDY AND SUBJECT	MD, OBSTETRICS AND GYNAECOLOGY
4	DATE OF ADMISSION OF COURSE	30th JUNE 2020
5	TITLE OF THE TOPIC	ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME.

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Fetal Growth Restriction (FGR) is failure to achieve a specific growth potential which is associated with an increased risk of perinatal mortality and morbidity. It has a relatively lower incidence i.e. 4-8% in developed countries compared to 6-30% in developing countries[1]. The average incidence of FGR is about 8% [2]. FGR is defined as estimated fetal weight <10thpercentile for gestational age [3]. 'FGR' is considered one of the most common and complex problems in modern obstetrics. Hence, early detection and timely intervention in FGR babies can help in significantly improving perinatal outcome.

Newborns weighing < 10th percentile for their gestational age are known as small for gestational age babies (SGA).[3]

50-70% of the Small-for-Gestation Age (SGA) fetuses are constitutionally small but healthy [4]. Approximately 10-15% of SGA fetuses are classified as 'true' FGR cases, and about 5-10% are associated with chromosomal/structural anomalies and chronic intrauterine infections [5]. Such FGR babies end up with low birth weight. FGR is a major cause of perinatal morbidity and mortality. FGR babies are at increased risk of fetal demise, birth asphyxia, meconium aspiration, neonatal hypoglycemia, hypothermia, abnormal neurological development, meconium aspiration, hypocalcemia and respiratory distress syndrome.

Growth restricted fetuses have not reached their genetic growth potential either due to a pathological cause or an event in utero which causes placental dysfunction. To continue a normal pregnancy, it is necessary to maintain a good utero-placental circulation as placenta is the only nutritional support available for the fetus. As pregnancy progresses, maternal, placental and fetal vasculature undergo a number of changes. Failure to adapt to these changes results in development of abnormal vascular resistance patterns and ultimately FGR. Evaluation of these vascular patterns efficiently helps in early identification and prediction of FGR.

Early diagnosis of FGR can be done by a combination of medical and obstetric history, clinical examination and ultrasound fetal wellbeing and Doppler. The most common methods for evaluating FGR have been the bio physical profile (BPP) and the non-stress test (NST). Unfortunately, neither of these tests is particularly sensitive for predicting poor outcome in FGR pregnancies. Color Doppler flowmetry indices (pulsatility and resistive indices of umbilical artery and middle cerebral artery, ductus venosus Doppler) evaluate the risk of fetal growth restriction efficiently and effectively. Ultrasound is frequently utilized in antenatal period to assess fetal size through serial biometric measurement. Earlier invasive methods such as amniocentesis and fetal blood sampling had to be performed repeatedly which was cumbersome. This non-invasive method has made assessment of pregnancies with FGR simpler compared from invasive methods.

FGR requires frequent monitoring and care so as to decrease it's complications. Doppler ultrasound is an important tool which measures blood flow through major fetal arteries and veins and is commonly used in assessment of pregnancies which are complicated by fetal growth restriction. Physiologically, systolic/diastolic ratio decreases with increase in gestational age because of a decrease in placental vascular resistance and an increase in end diastolic velocity. In FGR the EDF decreases due to shunting of blood to vital organs. These changes indicate an increase in placental vascular resistance. FGR infants who are born preterm are at a higher risk of complications compared from term neonates.

Umbilical artery Doppler assessment is useful in surveillance and obstetrical management of early onset FGR. MCA Doppler is an important tool in deciding the timing of delivery especially when the umbilical artery Doppler is normal.

6.2 REVIEW OF LITERATURE

Fetal growth restriction is a common obstetric condition which complicates up to 3-7 % of all pregnancies, constituting one of the greatest causes of maternal morbidity and mortality.[6]

Such FGR babies end up with low birth weight.

Causes of Fetal growth restriction (FGR):

Causes of FGR are diversified and can be classified as fetal, maternal, environmental and placental.

Causes of FGR can be divided as: 1)Non- Placenta mediated growth restriction – includes

a) structural and chromosomal / genetic anomalies (trisomies 18,13).

b) Congenital infections (rubella, cytomegalovirus, toxoplasmosis).

c) Inborn errors of metabolism.

2) Placenta mediated – is more common group i.e. that affect placental function: a) In 30-40 % cases, pre-eclampsia, chronic hypertension and gestational hypertension are complicated by FGR [7].

b) In 10-20% cases, diabetes is complicated by FGR irrespective of glycemic control [8].

c) Fetal growth is impaired by Maternal vascular disease, renal disease, thrombophilia, autoimmune disease as they lead to uteroplacental hypo perfusion thereby impairing fetal growth.

d) Hypoxemia due to cardiac, respiratory and hematological disorders may also cause FGR.

.After diagnosing FGR, a detailed history and clinical examination are the most important tools to differentiate fetal from maternal and placental causes and to plan antepartum management so that fetal outcomes can be improved.

TYPES OF FGR

Symmetrical

Asymmetrical.

Campbell and Thomas described the use of sonographically determined head-to-abdomen circumference ratio (HC/AC) to differentiate growth restricted fetuses [9] .Symmetrical FGR fetuses were proportionately small i.e. all parts of baby's body are similarly

small in size. In asymmetrical FGR fetuses there is disproportionately lagging abdominal growth i.e. size of baby's head and brain are appropriate to gestational age, but rest of baby's body is small.

An early insult in pregnancy results in a relative decrease in cell number and cell size, which might be caused by chemical exposure, viral infection, or inherent cellular development abnormality due to aneuploidy resulting in proportionate reduction in both head and body size termed as symmetrical growth restriction.

Medical conditions affecting late pregnancy such as pre-eclampsia, chronic hypertension cause placental insufficiency which mainly affects cell size. Placental insufficiency thereby results in decreased transfer of glucose and hepatic storage, thus, reducing abdominal circumference of fetus, which reflects the liver size. This sequence of events results in asymmetrical growth restriction. There is preferential shunting of oxygen and nutrients to the brain, which allows normal growth of brain.

Diagnosis of FGR:

Early and correct establishment of gestational age, attention to maternal weight gain, and careful measurement of uterine fundal growth throughout pregnancy identify many cases of abnormal fetal growth in low risk women. In women with significant risk factors, serial sonography must be done. Signs and symptoms of FGR such as poor maternal weight gain , development of hypertension, Reduced fetal activity and Small-for-dates pregnancy as determined by the symphysis – fundal height, SFH).Normal pregnancies progress at 1cm/week, so 30cm SFH at 30 weeks. Any SFH that is 3cm or more behind dates requires ultrasound investigations.

For an exact diagnosis of FGR one of important requirement is correct calculation of gestational age. Gestational age is confirmed by LMP or by first trimester ultrasound if not sure about LMP.

Following tests should be done:

Ultrasound scans Ultrasound scanning methods are used to observe fetal growth and analyze fetal biometry. USG is helpful in measurement of body parts like abdominal circumference, head circumference, biparietal diameter and femur length. Estimated fetal weight (EFW) is

calculated by using two parameters (AC and FL) and three parameter (BPD, AC and FL) models as described by HADLOCK and COWORKERS[10] . The average sizes are used as a reference range to decide if the developing foetus is small to its gestational age. If the estimated weight of fetus is below the 10th percentile, then it is defined as small-for-gestational age (SGA)and approximately 10-15 percent of these SGA fetuses are found to have TRUE FGR and rest 5-10 percent are associated with chromosomal / structural anomalies and chronic intrauterine infections[11] .

Doppler Studies Doppler studies are mainly useful in evaluating the blood flow to the fetuses. The fetal vessels that are commonly examined include umbilical artery, middle cerebral artery, and ductus venosus. In the umbilical artery, increase in systolic/diastolic frequency reveals an increase in impedance to blood flow in the placenta which happens due to rise in placental circulatory resistance as a result of decrease in number of tertiary villous arteries, which takes place due to maternal vascular diseases such as hypertension. Signs of deteriorating FGR can be assessed by reduction in diastolic flow, absent diastolic flow, or reversal in diastolic flow during a cardiac cycle.

Early-onset FGR i.e. FGR< 32 weeks gestation is associated with high impedance utero placental perfusion which increases blood flow resistance in umbilical artery [12]. In late-onset FGR i.e FGR diagnosed in pregnancies > 32 weeks gestation , there is no abnormality detected in uterine and umbilical artery. However, middle cerebral artery doppler are mostly abnormal due to hypoxia[13] .

UTERINE ARTERY DOPPLER

The relationship between abnormal uterine artery Doppler velocimetry, FGR and adverse pregnancy outcome is well established. Pregnancies complicated by FGR are characterized by failure of second wave of trophoblastic invasion of the endometrio -myometrial vasculature which normally occurs at 16-22 weeks. In first trimester of pregnancy, blood flow velocity waveforms is associated with low end- diastolic velocity and an early diastolic notch. Persistence of diastolic notch and an

abnormally high resistance in uterine arteries beyond 24 weeks of gestation indicates inadequate trophoblastic invasion .The parameters used in the assessment of uteroplacental blood flow include[14] :

- **RI** = resistive index
- **PI** = pulsatility index
- presence of persistent diastolic notching

Resistive index (RI)

This is calculated by the following equation:

RI = (PSV-EDV) / PSV = (peak systolic velocity - end-diastolic velocity) / peak systolic velocity

- normal (low resistance) RI <0.55
- high resistance
  - bilateral notches RI >0.55
  - unilateral notches RI >0.65

Pulsatility index (PI)

This is calculated by the following equation:

- **PI = (PSV - EDV) / TAV** = (peak systolic velocity - end-diastolic velocity) / time-averaged velocity

Abnormal patterns include

- persistence of a high resistance flow throughout pregnancy
- persistence of notching throughout pregnancy
- reversal of diastolic flow throughout pregnancy: severe state

UtA-PI 95th centile at POG>28 weeks gestation [15] .

POG	P95
24-27	1.17
28-31	1.11
32-35	1.47
36-37	1.30
38-39	1.09
40-41	1.55

UMBILICAL ARTERY DOPPLER

Umbilical artery Doppler is the only Doppler parameter that helps in providing both diagnostic and prognostic information for the management of FGR .According to RCOG use of umbilical artery doppler in a high risk population has been shown to decrease perinatal morbidity and mortality and should be the primary surveillance measure in predicting FGR in a fetus [16] . Normal umbilical artery flow is in a SAW – TOOTH PATTERN i.e forward flow in the direction of placenta. Umbilical artery flow identifies different degrees of abnormalities in placental function. Reduction in blood flow and severe fetal deterioration is indicated by an absent or reversed end diastolic flow .

The commonly used parameters are [17]:

- umbilical arterial S/D ratio (**SDR**): systolic velocity / diastolic velocity
- pulsatility index (**PI**) (Gosling index): (**PSV** - **EDV**) / **TAV**
- resistive index (**RI**) (Pourcelot index): (**PSV** - **EDV**) / **PSV**
- **PSV:** peak systolic velocity
- **EDV:** end-diastolic velocity
- **TAV:** time-averaged velocity

The Doppler indices have been found to decline gradually with gestational age (i.e. there is more diastolic flow as the fetus matures):

- S/D ratio mean value decreases with fetal age [18] .
  - at 20 weeks, the 50th percentile for the S/D ratio is 4
  - at 30 weeks, the 50th percentile is 2.83
  - at 40 weeks, the 50th percentile is 2.18
- RI mean value decreases from 0.756 to 0.609
- PI mean value decreases from 1.270 to 0.967

Classification of severity

In growth-restricted fetuses and fetuses developing intrauterine distress, the umbilical artery blood velocity waveform usually changes in a progressive manner as below

- reduction in end-diastolic flow: increasing RI values, PI values, and S/D ratio
- absent end-diastolic flow (AEDF): RI = 1
- reversal of end-diastolic flow (REDF

PULSATILITY INDEX [15]

POG	P95
24-27	1.34
28-31	1.27
32-35	1.18
36-37	1.16
38-39	0.98
40-41	1.10

FETAL MIDDLE CEREBRAL ARTERY DOPPLER

Middle cerebral arteries are the most accessible cerebral vessels for ultrasound imaging in the fetus contributing to 80% of cerebral circulation [19] .

Cerebral vasodilation is indicated by a reduction in PI of MCA which represents an adaptive mechanism in response to hypoxia.

Normally, fetal MCA has a high resistance flow.

In pathological conditions, fetal MCA has a low resistance flow as a result of fetal head sparing theory in which due to hypoxia, oxygen supply to brain is increased by vasodilation of cerebral arteries. MCA is valuable for identification [20] and prediction [21,22] of adverse outcome among late-onset FGR , independently of UA doppler which is normal in these fetuses.

POG	P95 [15]
24-27	3.04
28-31	2.97
32-35	2.91
36-37	2.51
38-39	2.29
40-41	2.78

CEREBROPLACENTAL RATIO:

CPR is a diagnostic index. It improves the sensitivity of UA and MCA doppler alone. Thus CPR is already reduced when its individual components undergo mild changes but still are within normal ranges [23,24] .

MCA-PI/ UA-PI

CP ratio : normal > 1.1

Abnormal < 1.1

DUCTUS VENOSUS

Ductus venosus is the strongest doppler parameter to predict short-term risk of fetal death in early-onset FGR [25]. Ductus venosus flow waveforms become abnormal only in advanced stages of fetal compromise. PI of DV is related to ph at birth, with higher DV pulsatility associated with lower ph at birth. Absent or reversed flow during atrial contraction are associated with perinatal mortality independent of gestational age at delivery and this sign is considered sufficient to recommend delivery at any gestational age after completion of steroids

TIMING OF DELIVERY

In patients with uncomplicated pregnancies and otherwise no concurrent findings with EFW between 3rd- 10th percentile monitoring should be done weekly and pregnancy can be continued upto 38-39 weeks of gestation. If EFW is less than 3rd percentile, pregnancy can be continued upto 37 0/7 weeks of gestation.[26]

In abnormal UA Dopplers i.e. decreased end diastolic flow delivery by cesarean section should be considered at 37 0/7 weeks gestation.

In case of UA- AEDV monitoring has to be done biweekly and delivery by cesarean section should be considered at 33-34 0/7 weeks.

In case of UA-REDF or DV-PI > 95th centile, monitoring has to be done every 1-2 days and cesarean section should be done by 30-32 0/7 weeks POG.

In case of DV – reverse atrial flow , Cctg < 3 ms and spontaneous FHR decelerations , monitoring has to be done every 12 hourly and CS should be done at or after 26 weeks.

6.3 AIMS AND OBJECTIVES OF THE STUDY

- To evaluate role of Doppler flow parameters in prediction and management of fetal growth restriction in antenatal patients
- To evaluate Doppler flow parameters with perinatal outcome.

7. MATERIALS AND METHODS

A prospective study will be conducted on pregnant women >26 weeks gestation attending antenatal clinic or admitted in department of obstetrics and gynaecology, Dayanand Medical College and Hospital , Ludhiana which is a tertiary care hospital. These patients would be subjected to USG fetal well- being and Doppler examination at 26-28 weeks,28-32 weeks and 32-36 weeks gestation for assessment of fetal well- being and diagnosis of FGR. All women being evaluated will undergo routine investigations and non-stress test for maternal and fetal surveillance. Further these pregnant women will be followed upto 7 days after delivery and various parameters indicating fetal outcome will also be recorded. This will be a prospective study conducted on 100 pregnant women. The data would be statistically analyzed.

7.1 Source of Data

The study will be performed in the Department of Obstetrics and Gynaecology, Dayanand Medical College and Hospital, Ludhiana, which is a tertiary care hospital.

This will be a prospective study conducted on 100 pregnant women > 26 weeks gestation.

7.2 METHOD OF COLLECTION OF DATA

INCLUSION CRITERIA:

Study will be done on 100 pregnant women attending antenatal clinic or admitted in antenatal ward of Dayanand Medical College and Hospital for evaluation. It will include all women being evaluated by Ultrasound fetal well- being and Doppler for fetal growth restriction, regardless of alerting signs and symptoms, suspected severity or comorbid condition. Informed consent will be done on for all patients. USG fetal well- being with Doppler will be done on for all patients. Those with abnormal Doppler findings will form study group A. Those with normal Doppler on USG will form group B.

Both primigravida and multigravida are included.

EXCLUSION CRITERIA:

- Twin / Multiple gestations .

- Congenital anomalies in baby.
- Extra uterine pregnancy.

STUDY SAMPLE

The study will be performed on 100 pregnant females > 26 weeks gestation gestation being evaluated by Ultrasound fetal well-being and Doppler, regardless of alerting signs or symptoms, suspected severity or comorbid condition.

NUMBER OF CASES: 100

STATISTICAL ANALYSIS: Prospective study and various biostatistics tests will be applied according to the data collected and tabulated

OUTCOME:

After admission detailed history, systemic and obstetric examination will be done. Accurate Gestational age will be calculated from last menstrual period or from first trimester ultrasound. Abdominal examination to determine the fundal height will be done. Routine investigations, Non stress test, and ultrasound fetal well- being and Doppler will be done for all patients. Patients fulfilling the inclusion and exclusion criteria will be selected for study. Informed consent will be taken from all participant patients.

The subjects enrolled for the study were followed up from the point of recruitment up to the time of delivery.

The primary outcome measures studied will be:-

1. Fetal growth parameters such as Biparietal diameter (BPD), abdominal circumference (AC), head circumference (HC), femur length(FL).

Estimated fetal weights will be estimated using two parameters (AC and FL) and three parameters (BPD, AC, FL) models as described by Hadlock and coworkers.

2. Ultrasound parameters such as

Umbilical artery,

Fetal middle cerebral artery,

Uterine artery

Ductus venosus Doppler

Determination of values of peak systolic velocity (PSV) in cm/sec, end diastolic velocity (EDV) in cm/sec , resistive index (RI), pulsatility index (PI) and S/D ratio will be done.

3. Mode of delivery (vaginal or caesarian)

4. Perinatal outcome such as

Live/still birth,

Birth weight,

APGAR score (1 min and 5 min),

ABG,

Admission to NICU,

Indication for NICU admission.

STATISTICAL ANALYSIS:

Correlation of Doppler findings with perinatal outcome will be analyzed using appropriate statistical methods. Data will be described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. Comparison of quantitative variables between the study groups will be done using Student t-test and Mann Whitney U test for independent samples for parametric and non-parametric data respectively. For comparing categorical data, Chi square ($\chi 2$) test will be performed and exact test was used when the expected frequency is less than 5. A probability value (p value)less than 0.05 will be considered statistically significant. All statistical calculations will be done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

All the above mentioned investigations are routinely performed as per the hospital guidelines. Hence will not pose any financial burden on the patient

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached herewith

LIST OF REFERENCES

1. Scott KE, Usher R. Fetal malnutrition: its incidence, causes, and effects. Am J Obstet Gynaecol. 1966,94:951–3.
2. Khanduri S, Chhabra S, Yadav S, Sabharwal T, Chaudhary M, Usmani T, Goyal A, Sharma H. Role of Color Doppler Flowmetry in Prediction of Intrauterine Growth Retardation in High-Risk Pregnancy. Cureus. 2017;9:e1827.
3. Martin JA, Hamilton BE, Ventura SJ, Osterman MJ, Wilson EC, Mathews TJ. Births: final data for 2010. Natl Vital Stat Rep. 2012;61:1-72.
4. Alberry M, Soothill P. Management of growth restriction. Archives Disease and Childhood, Fetal and Neonatal Edition. 2007;72:F62-F7.
5. Sheridan C. Intrauterine growth restriction. Australian Family Physician. 2005;34:717-23.
6. Romo A, Carceller R, Tobajas J. Intrauterine growth retardation (IUGR): epidemiology and etiology. Pediatr Endocrinol Rev. 2009;6:332-6
7. Villar J, Altman DG, Purwar M, Noble JA, Knight HE, Ruyan P, et al. The International Fetal and Newborn Growth Consortium for the 21st century (INTERGROWTH-21ST). The objectives, design and implementation of the INTERGROWTH-21ST Project. BJOG. 2013;120:9–26.
8. McCowan L, Horgan RP. Risk factors for small for gestationalage infants. Best Pract Res Clin Obstet Gynaecol. 2009;23:779–93.
9. Cunningham G, Leveno KJ, Bloom SL, Dashe JS, Hoffman BL, Casey BM, et al. Fetal growth disorders. In: Cunningham G, Leveno KJ, Bloom SL, Dashe JS, Hoffman BL, Casey BM, et al. (editors). Williams obstetrics. 25th edition. Mcgraw Hill: New York; 2018.

10. Hadlock FP, Harrist RB, Sherman RS, Deter Rl, Park SK. Estimation of fetal weight with the use of head, body and femur measurements. Am J Obstet Gynecol. 1985;150:333-7.
11. Sheridan C. Intrauterine growth restriction. Australian Family Physician. 2005;34:717-23.
12. Baschat AA. Fetal growth restriction – from observation to intervention. J Perinat Med. 2010;38:239–46.
13. Flood K, Unterscheider J, Daly S, Geary MP, Kennelly MM, McAuliffe FM, et al. The role of brain sparing in the prediction of adverse outcomes in intrauterine growth restriction: results of the multicenter PORTO study. Am J Obstet Gynecol. 2014;211:288-92.
14. Hacking C, Gaillard F. Uteroplacental blood flow assessment. Available from: https://radiopaedia.org/articles/uteroplacental-blood-flow-assessment?lang=us
15. Figueira CO, Surita FG, Dertkigil MS, Pereira SL, Bennini JR Jr, Morais SS, et al. Fetal Hemodynamic Parameters in Low Risk Pregnancies: Doppler Velocimetry of Uterine, Umbilical, and Middle Cerebral Artery. ScientificWorldJournal. 2016;2016:1693704.
16. Royal College of Obstetricians and Gynaecologists. The Investigation and Management of the Small-for-Gestational Age Fetus. RCOG Green Top Guidline No.31; 2014. Available from: https://www.rcog.org.uk/globalassets/documents/guidelines/gtg_31.pdf
17. Weerakkody Y, Radswiki. Umbilical arterial (UA) Doppler assessment. Available from: https://radiopaedia.org/articles/umbilical-arterial-doppler-assessment?lang=us
18. Acharya G, Wilsgaard T, Berntsen GK, Maltau JM, Kiserud T. Reference ranges for serial measurements of umbilical artery Doppler indices in the second half of pregnancy. Am J Obstet Gynecol. 2005;192:937-44.

19. Lugo G, Cassady G. Intrauterine growth retardation. Clinicopathologic findings in233 consecutive infants. Am J Obstet Gynecol. 1991;133:281.
20. Oros D, Figueras F, Cruz-Martinez R, Meler E, Munmany M, Gratacos E. Longitudinal changes in uterine, umbilical and fetal cerebral Doppler indices in late-onset small-for-gestational age fetuses. Ultrasound Obstet Gynecol. 2011;37:191-5.
21. Cruz-Lemini M, Crispi F, Van Mieghem T, Pedraza D, Cruz-Martínez R, Acosta-Rojas R, Figueras F, Parra-Cordero M, Deprest J, Gratacós E. Risk of perinatal death in early-onset intrauterine growth restriction according to gestational age and cardiovascular Doppler indices: a multicenter study. Fetal Diagn Ther. 2012;32:116-22.
22. Hershkovitz R, Kingdom JC, Geary M, Rodeck CH. Fetal cerebral blood flow redistribution in late gestation: identification of compromise in small fetuses with normal umbilical artery Doppler. Ultrasound Obstet Gynecol. 2000;15:209-12.
23. Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A. Cerebral-umbilical Doppler ratio as a predictor of adverse perinatal outcome. Obstet Gynecol. 1992;79:416-20.
24. Arbeille P, Maulik D, Fignon A, Stale H, Berson M, Bodard S, et al. Assessment of the fetal PO2 changes by cerebral and umbilical Doppler on lamb fetuses during acute hypoxia. Ultrasound Med Biol. 1995;21:861-70.
25. Figueras F, Gratacos E. Update on the Diagnosis and Classification of Fetal Growth Restriction and Proposal of a Stage-Based Management Protocol. Fetal Diagn Ther. 2014;36:86–98.
26. ACOG practice bulletin no. 204. American College Of Obstetricians and Gynecologists. Obstet Gynecol. 2019;133:e97-109.

PROFORMA

Sr. No

Name:-

Age:- <20 21-25 26-30 >30

Date of admission:-

Admission number:-

MRD number:-

Residential address:- rural urban

Education:- undergraduate graduate postgraduate

Occupation:- housewife employed

Parity:- P1 P2 P3 P>3

Booked/ Unbooked

Menstrual history:-

LMP:- date regular/irregular cycle length

EDOD:-

POG:-

- Obstetric history:-
- Risk factor of developing FGR :- Fetal causes - chromosomal/ structural / genetic abnormality

Placental causes - single umbilical artery / abnormal placental implantation / bilobed placenta

Maternal cause - nulliparity / grand multipara

HTN / renal disease / vasculapathy / autoimmune disease / DM2

Period of gestation when she developed FGR :-

Past history:-

Family history:-

Socio-economic history:-

Nutritional history:-

Period of gestation at the time of delivery:-

Mode of delivery:-

Vaginal (with forceps/ without forceps

Caesarean

- Indication of caesarean :-

Signature of Candidate **Signature of Supervisor**

- Neonatal details:-
- Date and time of birth:-

A)LIVE BIRTH

- Term/ pre-term
- Birth weight
- Sex of baby
- APGAR SCORE :- AT 1 MINS
  AT 5 MINS
- Admisssion to NICU:- YES / NO
- Indication of admission:-

B) STILL BIRTH

- Perinatal complications :-

- General physical examination:-

P/A : Fundal height : a) corresponding to POG
b) lag

INVESTIGATION:-

1. NST
2. ULTRASOUND:- AC
   BPD
   FL
   HC

Signature of Candidate **Signature of Supervisor**

DOPPLER PARAMETERS :

	26-28 weeks		
	S/D	PI	RI
Uterine Artery			
Umbilical Artery			
Middle Cerebral Artery			

	28-32 weeks		
	S/D	PI	RI
Uterine Artery			
Umbilical Artery			
Middle Cerebral Artery			

	32-36 weeks		
	S/D	PI	RI
Uterine Artery			
Umbilical Artery			
Middle Cerebral Artery			

	26-28 weeks	
	Normal	Abnormal
Cerebro Placental Ratio		
Ductusvenosus Doppler		

	28-32 weeks	
	Normal	Abnormal
Cerebro Placental Ratio		
Ductusvenosus Doppler		

	32-36 weeks	
	Normal	Abnormal
Cerebro Placental Ratio		
Ductusvenosus Doppler		

Signature of Candidate **Signature of Supervisor**

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o.....

.....am willing to participate in the study **"ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____
निवासी _____

इस शोधकार्य **"ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"ROLE OF COLOR DOPPLER FLOWMETRY IN PREDICTION OF FETAL GROWTH RESTRICTION AND CORRELATION OF DOPPLER PARAMETERS WITH PERINATAL OUTCOME" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ